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PAGE'S MAGAZINE

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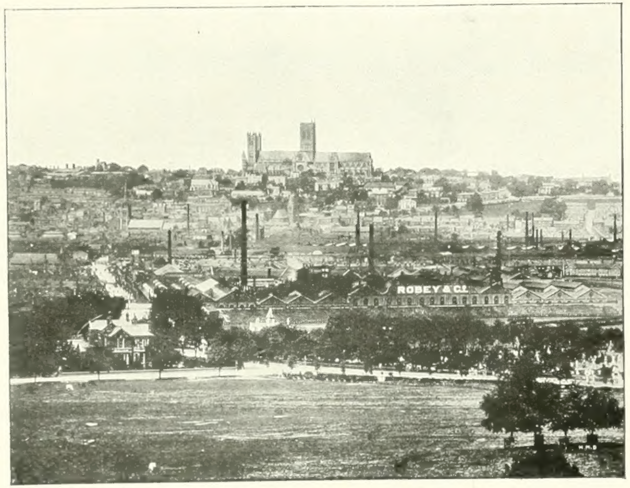

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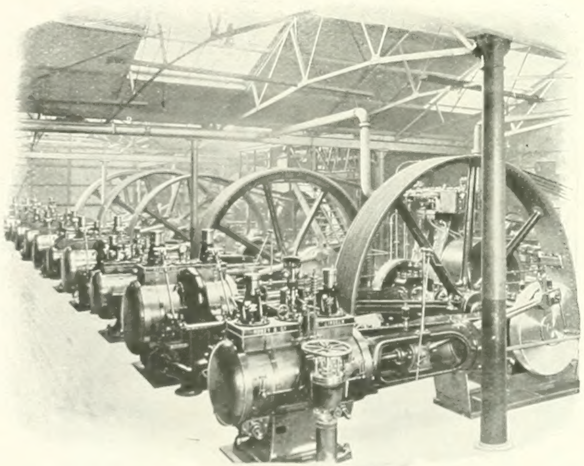

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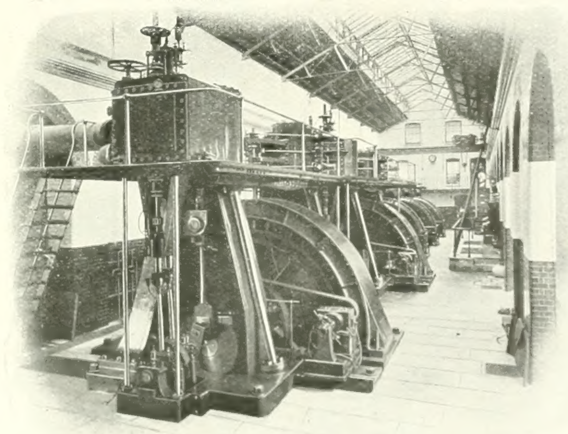

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NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 57, 59, 60, 62.*

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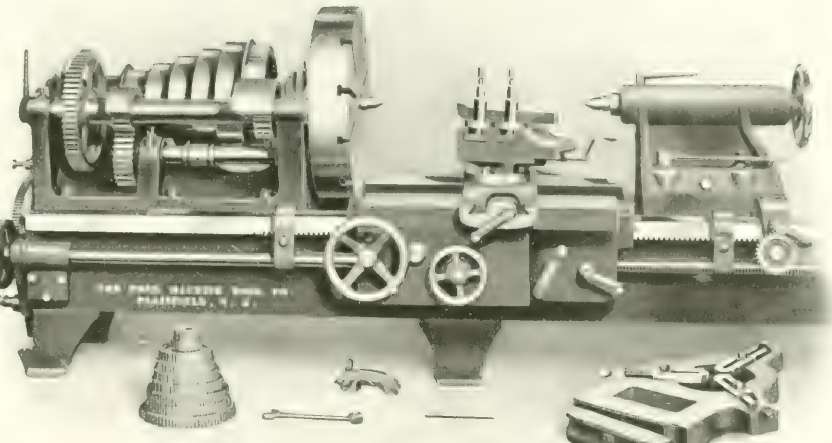

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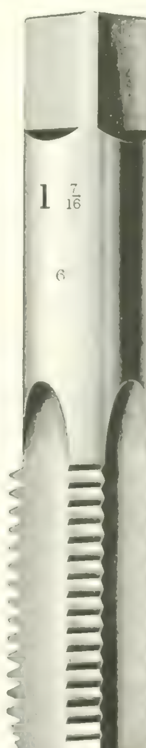

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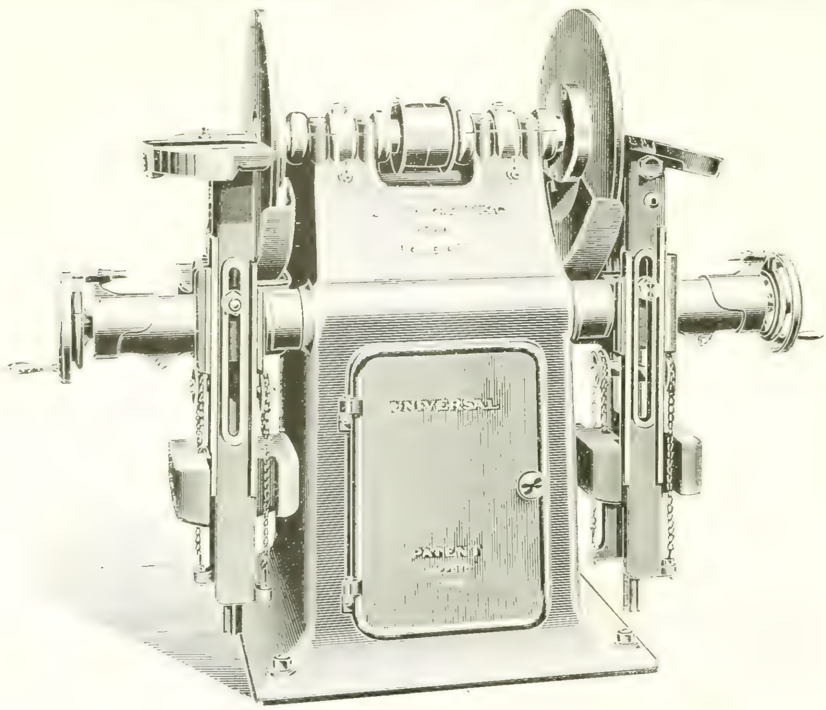

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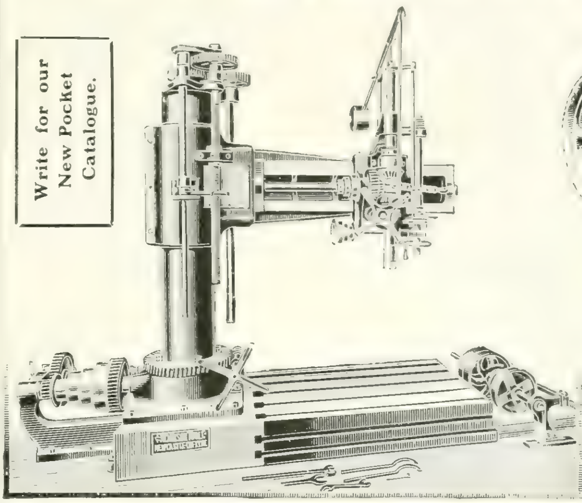

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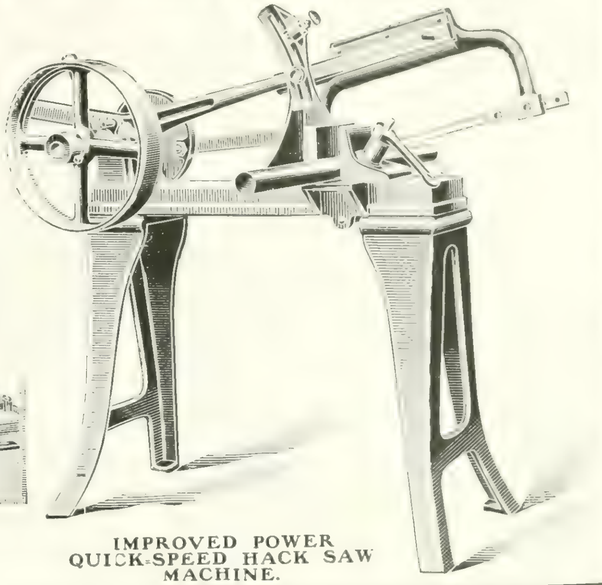

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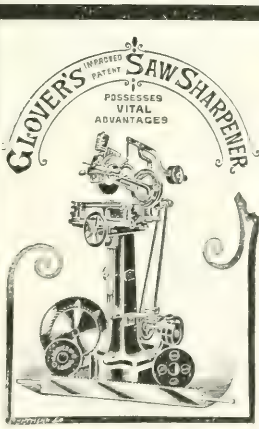

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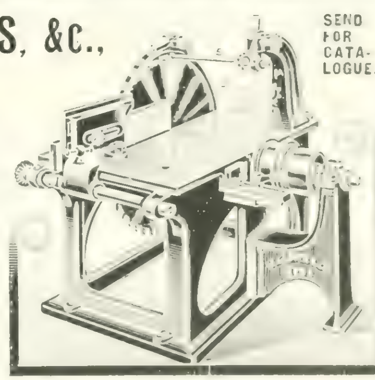

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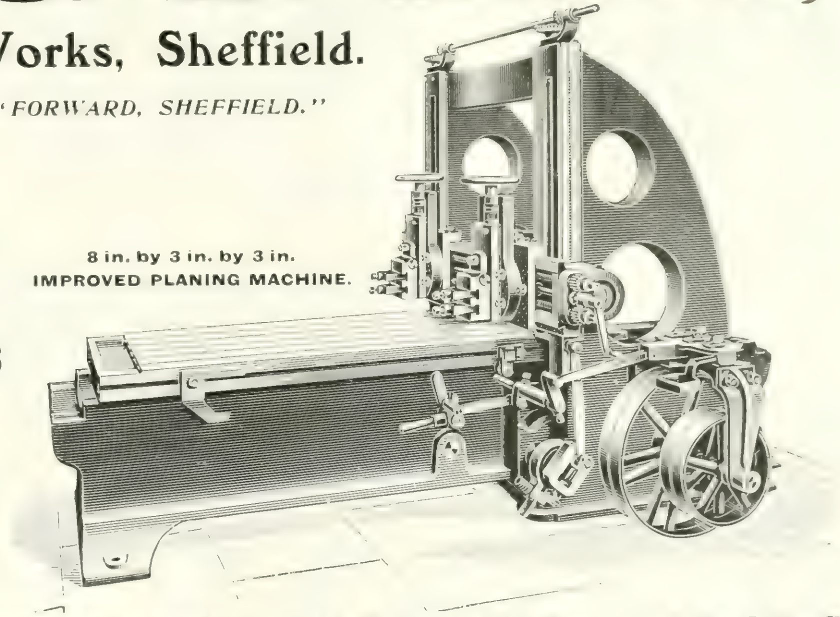

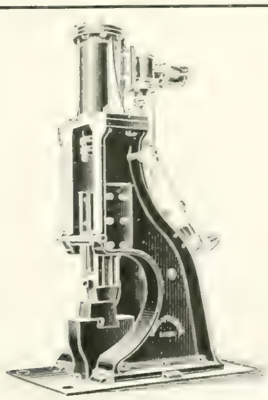

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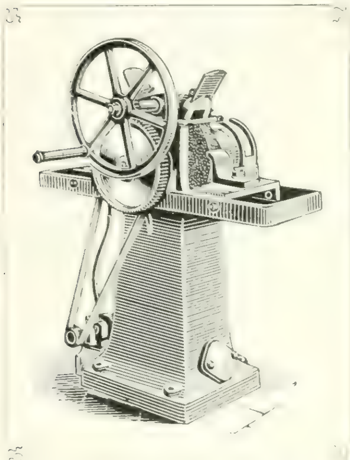

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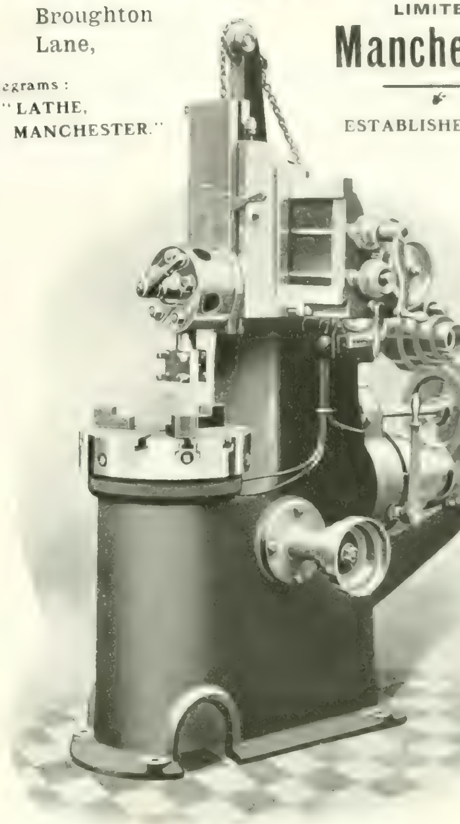

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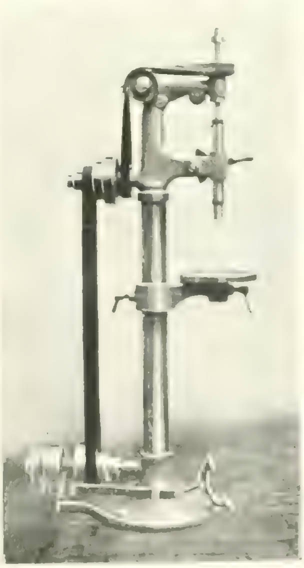

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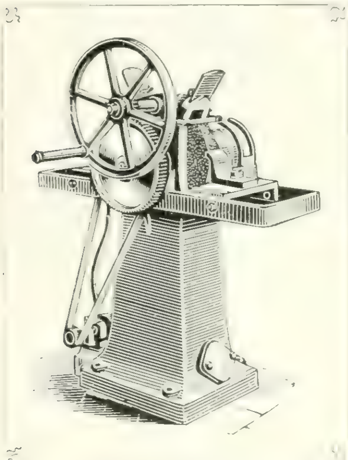

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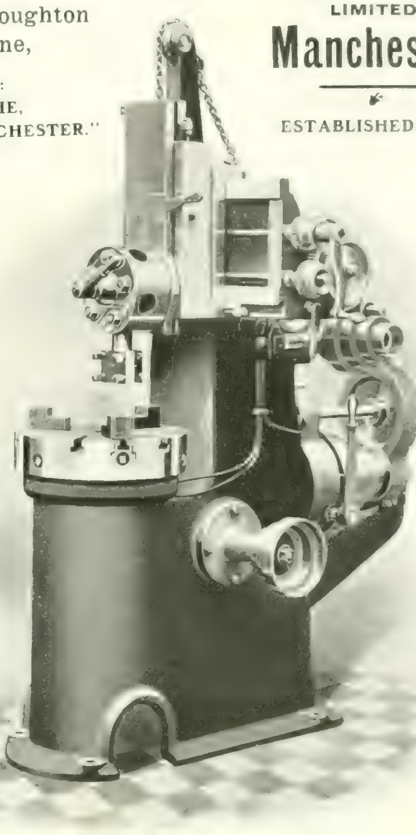

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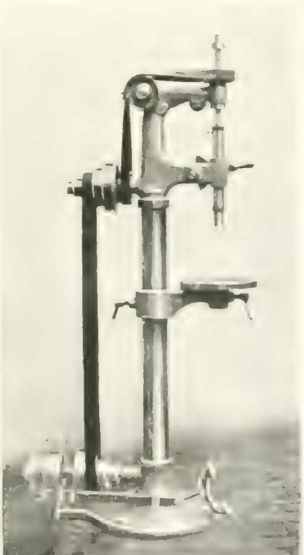

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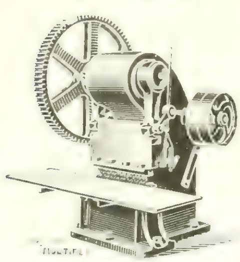

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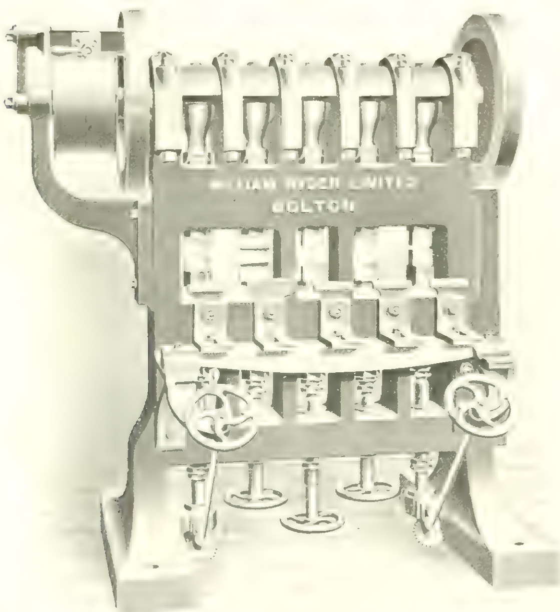

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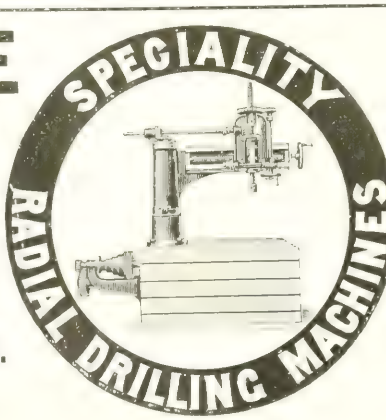

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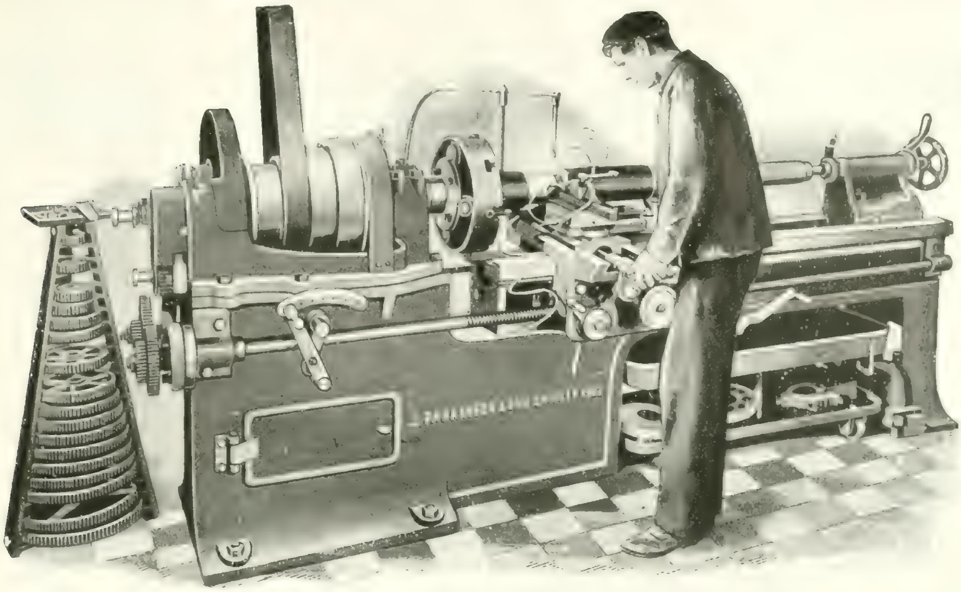

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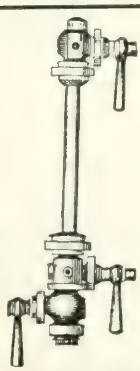

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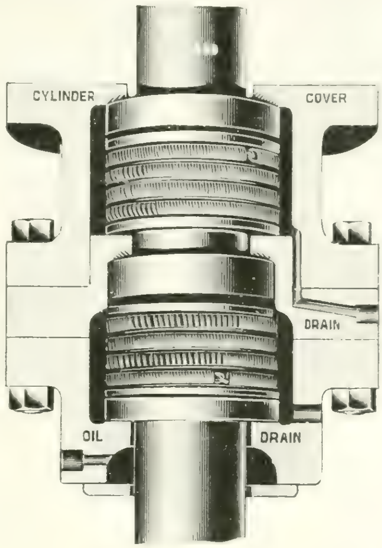

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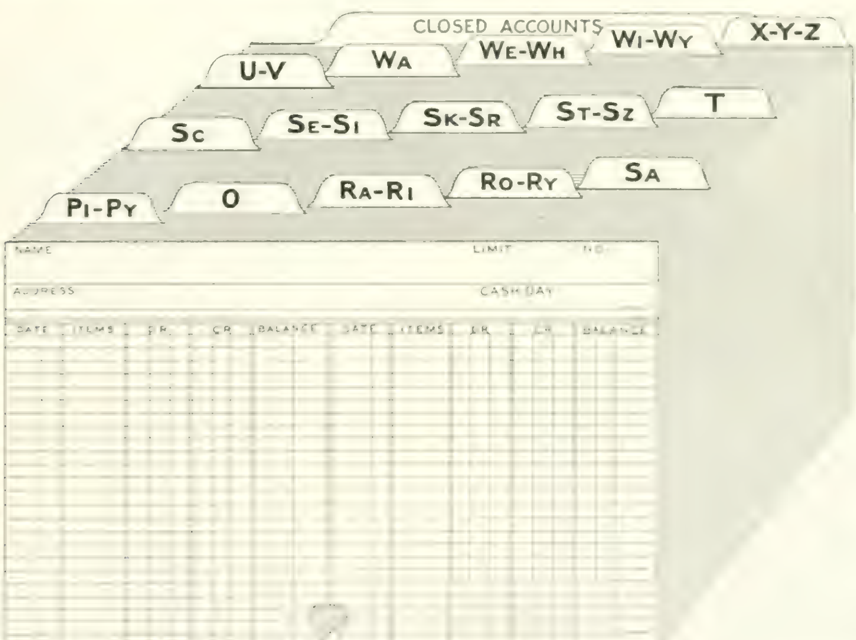

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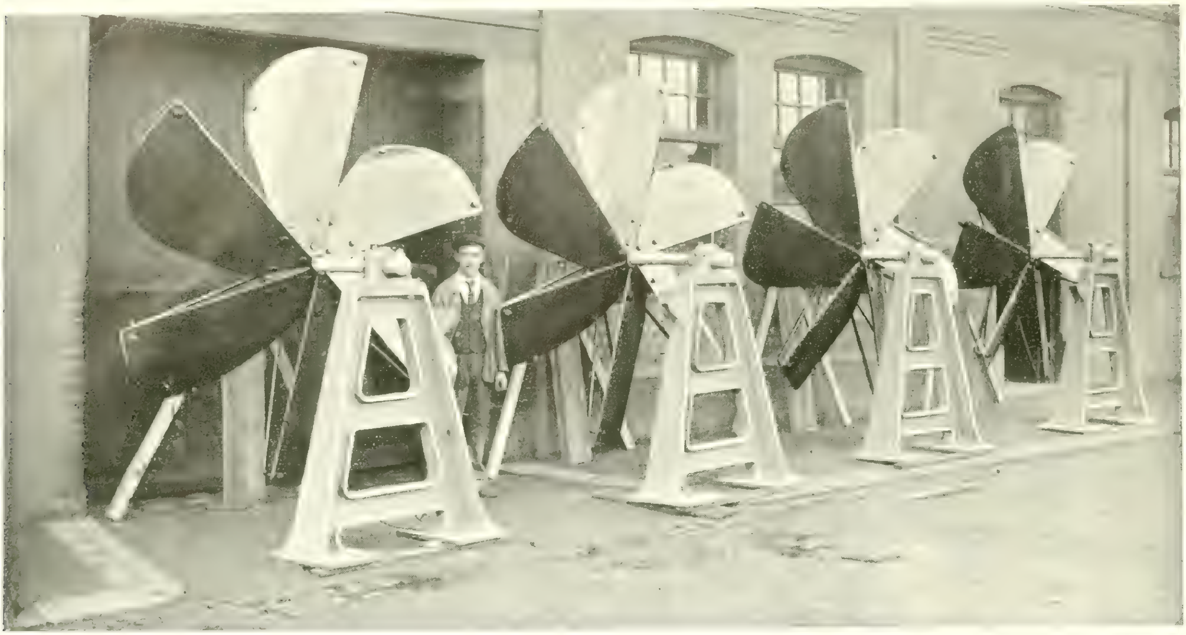

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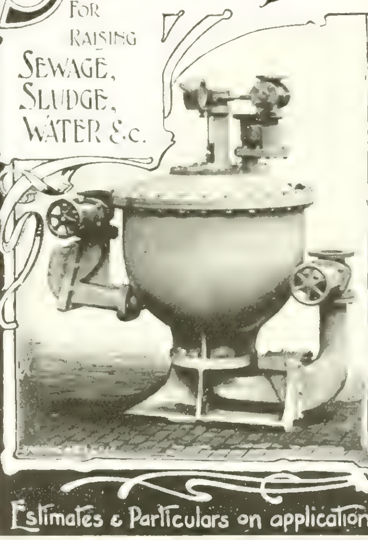

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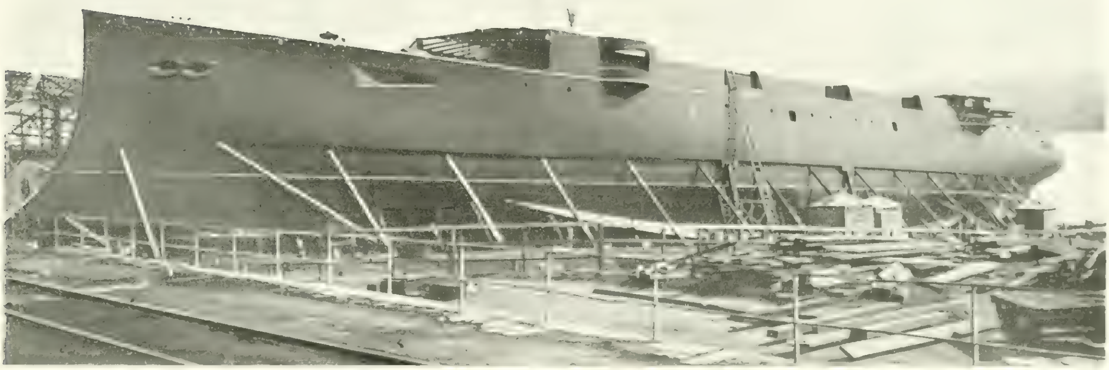


CRUISER READY FOR LAUNCHING—FERROL ARSENAL.

THE RECONSTRUCTION OF THE SPANISH NAVY.

BY

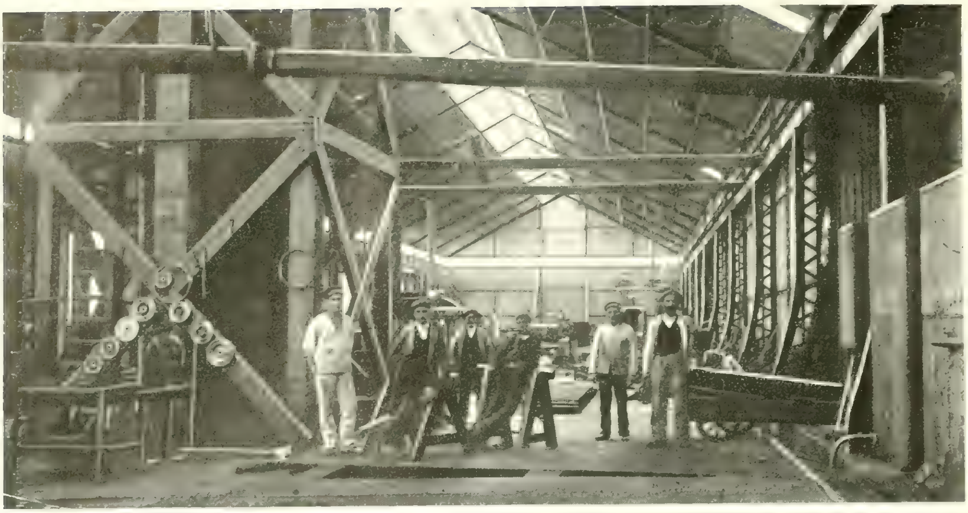
LIEUT.-COLONEL L. CUBILLO.

(Of the Royal Spanish Artillery.)

Lieut.-Colonel Cubillo, who occupies a prominent position under the Spanish Government, discusses the various practical considerations that are likely to arise in connection with the reconstruction of the Spanish navy—a measure now seriously contemplated by his countrymen. He argues that, except for the manufacture of armour-plate, the internal resources of Spain are entirely adequate for the purpose.—ED.

SPAIN has ceased to lament the misfortunes of the late war. She has applied herself seriously to a consideration of the cause of defeat, and as there is every indication that she is seriously contemplating the reconstruction of her navy it becomes desirable to review the whole question from an industrial point of view.

What plan should be followed in an undertaking of such great importance? When this question is asked, it is assumed that a naval programme has already been decided upon.



BENDING AND SHAPING SHOP—FERROL ARSENAL.

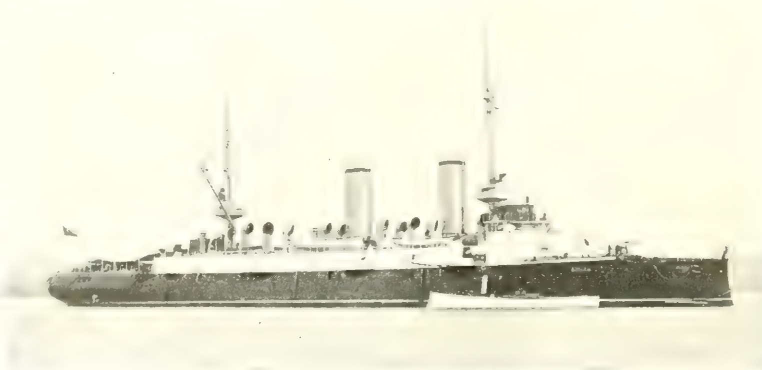
The next thing necessary will be the appropriation of the required funds, and then will come the momentous question of whether the construction should be carried on in foreign countries, or in Spain; if in Spain, whether it should be carried on by the Government Navy Yards exclusively, or by private enterprise exclusively, or whether both should be employed. We shall try to show in the following article that, with the one exception of the manufacture of armour-plate, there are ample facilities for constructing a navy in Spain.

THE INTRODUCTION OF SKILLED LABOUR AND MACHINERY.

Nothing should come from the outside world, except what is absolutely necessary, *i.e.*, such articles as are not manufactured in Spain, or cannot conveniently be made there. In view of the sacrifice which the nation is to impose upon herself, in order to build a navy, care should be taken that the greater part of the money expended remains in Spain, developing her riches, and increasing her metallurgical industries. No endeavour can be considered as unproductive that tends to develop the iron industries of the country, and in this connection it must not be forgotten that the Spanish deposits of iron ore are among the richest in Europe, while there is also an abundance of coal.

It is not suggested that the authorities should avoid the introduction of such necessary elements as skilled labour and machinery. Outside assistance of this description is indispensable when new branches of industry are to be created.

The construction of the modern American navy is a case in point. The task was given to private corporations, which had no practical experience in building ships of war, and engineers and foremen of dockyards, experienced in the



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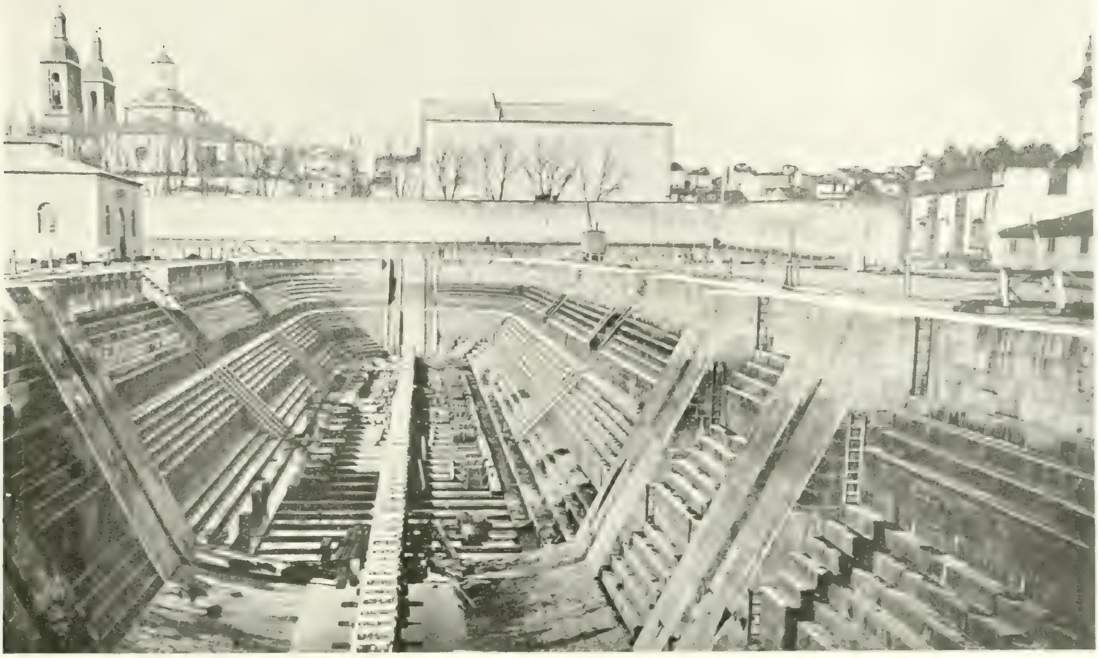

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details of ship building, were brought over in haste from the coast cities of Scotland and Great Britain—especially the former. These men taught the Americans so well that a certain English engineer, when describing his visit to the Cramp yards, said that the only tongue one could hear spoken there was the Scotch dialect.

No obstacles should be placed in the way of bringing skilled labour to the country; in fact, everything should be done to encourage its coming, in order that Spanish engineers, foremen of dockyards and mechanics, who, as a general rule, are very intelligent, may learn such parts of their professions as are not well known in Spain.

DISPOSAL OF CONTRACTS.

Assuming that the new navy will be built in Spain, the question arises whether the contracts should be given to private corporations or to Government Navy Yards, or both. The recent law regarding the organisation of arsenals settles this point to a certain extent, for it reserves two arsenals, those of Ferrol and Cartagena, for construction and repairs. But should the Government Yards have *all* this work? The author favours a distribution of the work among the Government Navy Yards and private concerns according to their capacities. This is the system adopted in England, where the Admiralty distributes the construction work covered by each appropriation, in proportion to the productive capacity of the various industrial districts.

ALLEGED DEFECTS OF SPANISH ARSENALS.

Much is said concerning the defects of our arsenals, but these defects are not found only in Spanish arsenals; they exist in the arsenals in every country, and manifest themselves clearly when there is a slackness of employment.

The defects which are found in the workshops of Spanish Navy Yards find their origin chiefly in the interruption of constructional work. A period of great activity is succeeded by one of great depression, the problem of dealing with the superfluous hands being one of great difficulty. The highest ambition of a Spanish workman is to work always in the place where he was born; at least a very large majority regard this as their ideal, and they insist, where it is possible, that their children shall work at the same trade as that by which they are making a living.

In common with the other Government organisations working under the administrative system, the arsenals labour under difficulties connected with the purchase of supplies, their buying powers being restricted by the famous law of Bravo Murillo, which compels the invitation of public bids for the purchase of supplies, even in the case of a mere trifle.

BETTER SYSTEMS NEEDED.

Instead of having an official in charge of the purchasing department, who would act in accordance with the technical conditions laid down by the engineers, the department order calls for an economic committee, which must do all the buying. The reason for this is the distrust which the Spanish Government entertains towards its employees. It never entrusts to a single individual anything of importance, either administrative or technical. To carry out anything at all there must be a committee, and its members must belong to different departments, no doubt in order that they may watch each other. There is thus ample provision for long discussions, a lessening of responsibility, and the creation of every kind of obstacle to the transaction of business.

It is evident that in any scheme of reconstruction ample facilities must be provided for the acquisition of raw material. The purchasing department should be well organised and placed under the control of an active and energetic body of officers, experienced in commercial life. The important question of ways and means and their application to the business in hand should also be placed in competent hands.

NEW TOOLS REQUIRED.

Before the new work of building war vessels is begun, it will be necessary, in the opinion of the writer, that a preparatory period be given to the arsenals for the acquisition of new tools. These tools will enable the work to be done much more rapidly and cheaply than it is done to-day. By the word tools we mean everything from the most powerful machine or crane down to the smallest hand tool.

Three different departments are necessary to the completion of a battleship. The navy yard proper, where the hull is made; the engine and machine shops where the engines are erected, and the infinite number of auxiliary machines are constructed; and finally the gun shops and armour-plate mills where the offensive and defensive arms of the ship are produced.

Let us carefully examine the facilities which Spain has for building battleships, both as regards raw material and mechanical equipment.

BOILER PLATES, CASTINGS, ETC.

Fortunately there is no scarcity of mills in Spain capable of furnishing plates of suitable character for naval construction. The mills of the "Sociedad Duro Felquera" and those of "Los Altos Hornos" of Vizcaya, have furnished to the Government and private ship yards excellent boiler plates, as well as sheathing plates. The Mieres mill is now erecting a powerful reversible set of rolls, and, if necessary, the Trubia Mill could also furnish these materials. as they have just finished their new plate mill, which is provided with all modern improvements. The same mills which roll the plates can also furnish beams and channels of large dimensions. They are all provided with tools for this purpose. Hence, as far as the hull is concerned, Spain is able to furnish all the necessary materials, and of a sufficiently excellent quality to satisfy the most exacting specifications.

Since the year 1883, when the Bilbao mills began to use the Bessemer process, and since 1888, when the Felguera mills started their Siemens plant, Spanish concerns have dominated the manufacture of soft steel—the most valuable material which the engineer has at his disposal.

The mills would also have to turnish large steel castings for the base plates of engines, stem and stern posts. Castings of the required weight are not as yet made in Spain, but the machinery for the making of these castings is not expensive, and the problem will be quickly solved by the large mills of Spain.

STEAM ENGINES.

With regard to steam engines Spain has the materials and the ability to build marine engines, whether for a battleship or protected cruiser of large displacement and fast speed. The works of "Maquinista Terrestre y Maritima" and the "Astilleros de Bilbao" have shown that they know how to construct triple and quadruple expansion engines of the most advanced types. Rear-Admiral Melville, U.S.N., discussing the best manner of economically obtaining two speeds for a man-of-war, one for cruising in times of peace, and the other a maximum speed in time of war, suggests the use of three sets of engines, coupled to three propellers, and it may be that in future battleships this idea will be carried out. The central engine is used for cruising in times of peace, and the three together for producing the maximum speed. This, of course, would lead to the buiiding of engines of medium power, and consequently of easier construction. It is risky to prophesy, but the progress which the Hon. C. A. Parsons has made with his steam turbine as applied to the propulsion of ships, may lead to the use of the steam turbine for ships of medium displacement. There is no doubt but that the factories of the Catalonian Provinces are able to furnish all the necessary electrical machinery of the best quality, not only for generating light, but for other necessary services on board ship.

GUNS.

In Spain there are at this time machines of sufficient capacity for producing all parts of the guns which will be necessary for the new navy. The tools recently installed at Trubia, with a small appropriation to put the 1,200-tons Tannett-Walker press in the same condition as the new 3,000-tons Whitworth press, will place the arsenals in a position to manufacture all the tubes, hoops, etc., for the guns for the new navy.

At Astilleros there is still another powerful forging press of the same capacity as the one at Trubia and made by the same manufacturer; but at the present time this press is not being used, as it is not needed.

ARMOUR-PLATE.

Concerning the manufacture of armour-plate the same cannot be said. For the manufacture of armour-plate required by the modern battleship and protected cruiser, Spain has nothing which could be used, and would have to instal an entire plant. She is interested to find out whether it would be well for her to establish either a private or Government armour-plate mill.

Let us now see whether it would be convenient to the interests of the country to establish either a private or a Government plant of this character. From an economical point of view our answer is categorical—it is not convenient to build such a plant. Spain, no matter how large a navy she intends to build, would surely not require more than sixteen battleships, and no matter how rapidly the construction of these was pushed, we believe she would not aspire to construct more than two ships per annum, thus completing the navy in eight years. Would it be worth while to establish a plant the usefulness of which is to last so short a time, and the cost of which is to be written off so soon? We believe it would not.

We would only recommend trying to manufacture armour-plate in Spain provided it were undertaken by a private concern, which could manage its plant so admirably, both technically and economically, that it would be possible to produce plates as cheaply or cheaper than in a foreign country.

It would also be advisable to manufacture armour-plate in Spain if the country had the idea of building one or two battleships each year for an indefinite number of years. One great objection to building an armour-plate plant is that it is not adapted to any other line of steel manufacture, and with the exception of the Siemens furnaces—the presses, the cementing furnaces, the heavy planers and other machine tools would be useful for no other purpose.

We have spoken already of the technical difficulties which surround the manufacture of armour-plate. The troubles and difficulties which such exacting work gives to the engineer are too numerous to be counted. We shall mention in proof of this opinion, one bit of testimony of great weight, *i.e.*, that of Mr. Carnegie, a man of wide experience in the manufacture of steel.

His report to the Naval Committee of the American Senate was to the following effect: "In the works of my company we obtain monthly 150,000 tons of common soft steel and from 200 to 300 tons of armour-plate. The 300 tons of armour-plate give us more trouble than the 150,000 tons of common steel. If the Government so wishes, I am willing to sell my plant, and I will do even more, I will teach the process of manufacture to the officials who may be designated. When I started in this business it was solely owing to patriotic motives, and to my having been strongly urged by the President of the Republic, who considered the matter of the highest importance to the nation. I have devoted all my energy to this plant, and three large gangs of workmen have worked at the installation of the shops day and night and holidays included, changing off each eight hours, and we have completed the plant in a very short time. For a service of this kind the dignity of a peer would surely have been given to me in England; in France I would have been graced with the insignia of the Legion of Honour."

This was his way of giving vent to the many troubles he had encountered in the manufacture of armour-plate, and the enormous profits which he realised in the manufacture of steel, especially during the last period of high prices, when the profits obtained were more than 10,000,000 dols., did not come from armour-plates, but from the 200,000 tons of soft steel.

In the armour-plate industry more than in any other a long period of apprenticeship is necessary; the plates are neither forged nor cemented, tempered nor shaped, even where people are familiar with their manufacture, without a great loss of time and money. For this reason, the Japanese, who are building an armour-plate plant, have announced that they will not commence to make deliveries before seven years. It is clear that this time could be shortened considerably if there is an unlimited supply of money, and if the new plant is put in charge of experienced engineers.

Finally, summing up in a few words our ideas, we should say that the construction of the future navy can and should be done with domestic raw material, with the one exception of the armour-plate. In this way 75 per cent. of the appropriation voted would remain in Spain to develop her resources and wealth.

PATTERN SHOP AT THE BRITISH WESTINGHOUSE WORKS, SHOWING VENTILATING PIPES.

THE LAYING OUT OF ENGINEERS' WORKSHOPS.

BY

JOSEPH HORNER.

The present article is concerned with the ventilation and warming of Engineers' buildings, special attention being paid to the needs of large shops. Some instructive typical examples of new plants are included. Previous articles have dealt with General Conditions (March, 1903), the Separate Units Comprised in an Engineers' Works (April), Ground Plans (May), Walls and Roofs (June), Floors, Tracks, and Windows (July).—ED.

VI.

IMPORTANCE OF PROPER VENTILATION AND WARMING.

IN modern workshops the ventilation and warming of shops are important considerations, though in many of the older works they do not appear to have been considered at all. It is, of course, not only a question of comfort for the hands; it is also one for the employers. Formerly, if men complained of cold, the retort was, "Warm yourself with your work"—advice which, if carried out, meant more work produced. That is no longer possible in large departments where men are simply machine-minders, and where cold fingers and chilblains prevent proper handling of fine mechanisms. Inanimate objects suffer in damp shops, becoming rusty, and involving extra labour to clean them. This state of things is happily changing, for few firms would now lay out new works without including efficient ventilation and warming in the design.

In America, where the extremes of temperature are greater than they are with us, the systems in use are highly developed, and a very important point is, that the same apparatus is used for warming in winter and for cooling in summer, ventilation and warming being

combined. This involves the installation of a large system of pipes, a heater, or heaters, and a fan or fans. Air is the medium employed.

Hitherto, when heating has been employed at all in England, it has been more often done by means of exhaust steam or hot-water pipes, while commonly ventilation is only obtained in crude fashion by the device of opening and closing of windows or ventilators.

Whatever system of ventilation and heating is selected, a decision should be arrived at before the buildings are commenced, so that suitable provision can be made in due course for the various fittings, openings, foundations, etc., that are required.

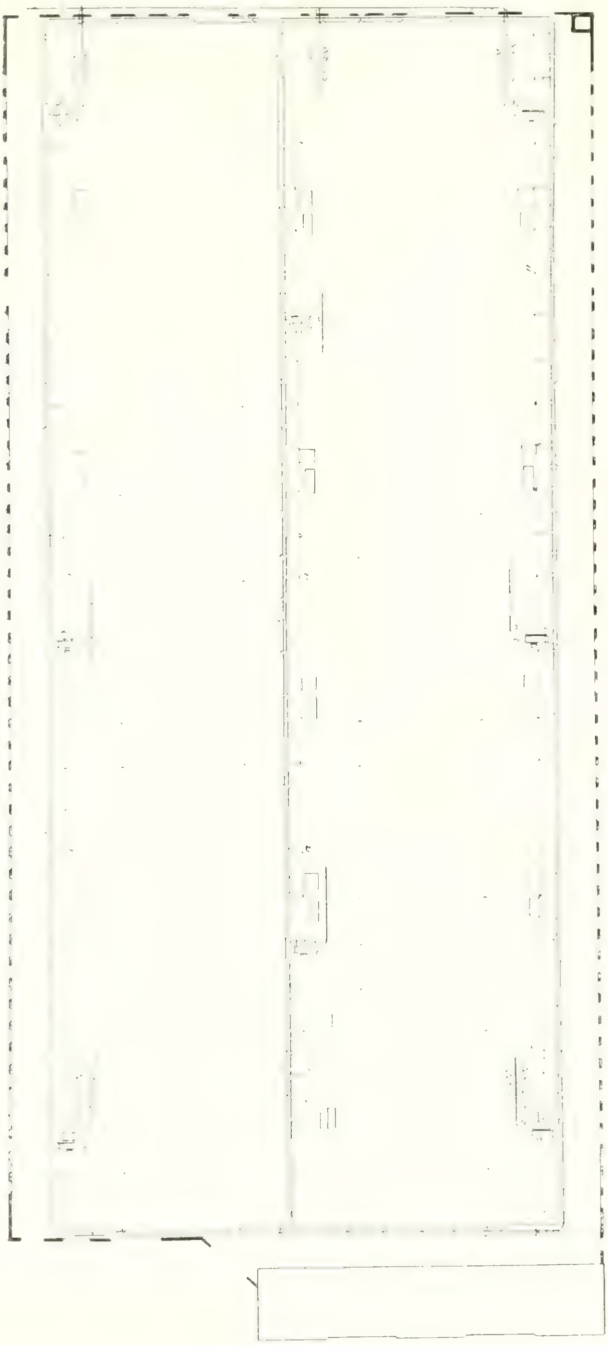


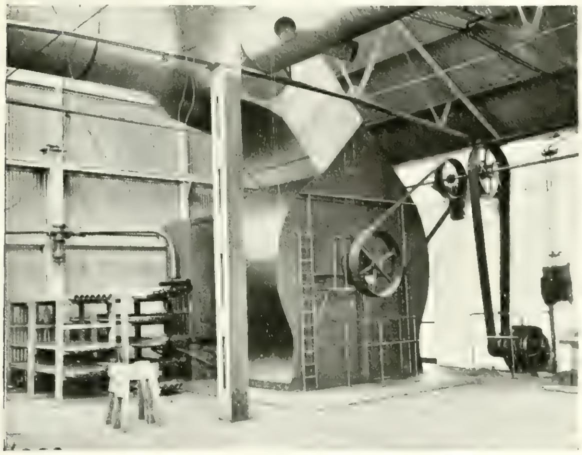
FIG. 1. GENERAL PLAN OF AIR PIPING THROUGH MAIN MACHINE SHOP, BRITISH WESTINGHOUSE WORKS.

THE TRUE STANDARD OF PURE AIR SUPPLY.

A very inadequate standard for wholesome conditions of breathing has long been adopted, that of a minimum of so many cubic feet of air space for each individual—about 250 cubic feet. But this is of no practical value apart from the more important question of the constant and regular renewal of the air. A capacity of ten times this volume would become vitiated unless means were provided for free ventilation. Half that capacity would be sufficient with rapid renewal. The proper test is the volume of carbonic acid present at any period, nine to ten volumes of this gas per 10,000 ft. of air being the maximum which should be allowable. But in engineers' workshops, built on the one floor design, the cubic capacities are so far in excess of those required that rapid renewal of the air is not so necessary as it would be, for instance, in storied buildings, crowded with small machines and many hands.

THE OBJECTIONS TO VENTILATION BY MEANS OF WINDOWS.

Ventilation as commonly obtained by the device of opening windows, and by the employment of fixed and hinged louvres and ventilators, is subject to the strong objection of the setting up of draughts. Men who are occupied near the windows have to endure the inflow of cold air for the benefit of those who are nearer the centre of the building, and those who object to this vicarious sacrifice are subject to unkind remarks. In winter time this crude form of



PLANT NO. 3. HEAVY GUN-MOUNTING DEPARTMENT OF MESSRS. VICKERS, SONS AND MAXIM, LTD., BARROW-IN-FURNESS.

The fan has a capacity of 75,000 cubic feet of air per minute.

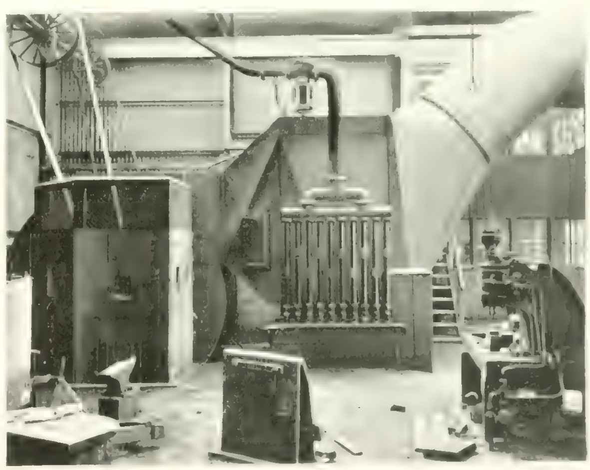
ventilation is unendurable, and rather than face the chilling gusts of fresh air from outside, the internal air is allowed to become stagnant and heavily laden with carbonic acid, to which the burning of gas often adds its quota. And then, too, the shops are cold unless artificial warmth is produced, and this is what is not done in one half the works in this country. It is very unusual, even now, to find a foundry or a boiler shop, or a big machine shop warmed in winter. The small departments are not infrequently warmed with stoves, or with hot-water pipes, or exhaust steam pipes; but little more than this has been done. Only in some of the works built within the last four or five years has the necessity for sufficient ventilation and adequate warming been recognised and carried out.

WARMING BY HOT WATER.

The system of warming by hot water, heated in a stove in the basement, and circulated through a return system of pipes, is wasteful when applied to a large shop, and it is not capable of precise regulation as a whole, to say nothing of that local control which it may be desirable to exercise in different shops, rooms, or offices. One or two hours are occupied in the morning in getting the apparatus in full swing. The system takes no account either of ventilation, while the act of ventilating by windows abstracts some of the heat derived from the pipes. Another trouble with the hot-water system is that it is very difficult to get a large shop comfortably warmed when the weather is considerably below freezing outside. Neither can it be utilised for cooling a shop in summer time. The hot-water system is probably the best for offices, combined with radiators, in which, however, it divides favour with stoves. In some of these the temperature can be controlled by an electric device, which contains a thermometer and a switch in combination. A pointer can be set on a graduated scale to indicate the temperature desired, and an electric controller maintains the temperature here unaltered.

STOVES FOR OFFICE BUILDINGS.

There are many shops of moderate dimensions for which a system of heating pipes is not necessary, but for which a stove would answer the purpose. In a storied shop a stove in the basement, with hot air flues, is suitable, as it is for offices, providing both warming and ventilation. The Musgrave slow combustion stoves are thus used, and also in several engineers' shops of large dimensions. In this system



FIELD-CARRIAGE SHOP OF MESSRS. VICKERS, SONS AND MAXIM, LTD., BARROW-IN-FURNESS.

Capacity of fan, 53,[illegible] cubic feet of air per minute.

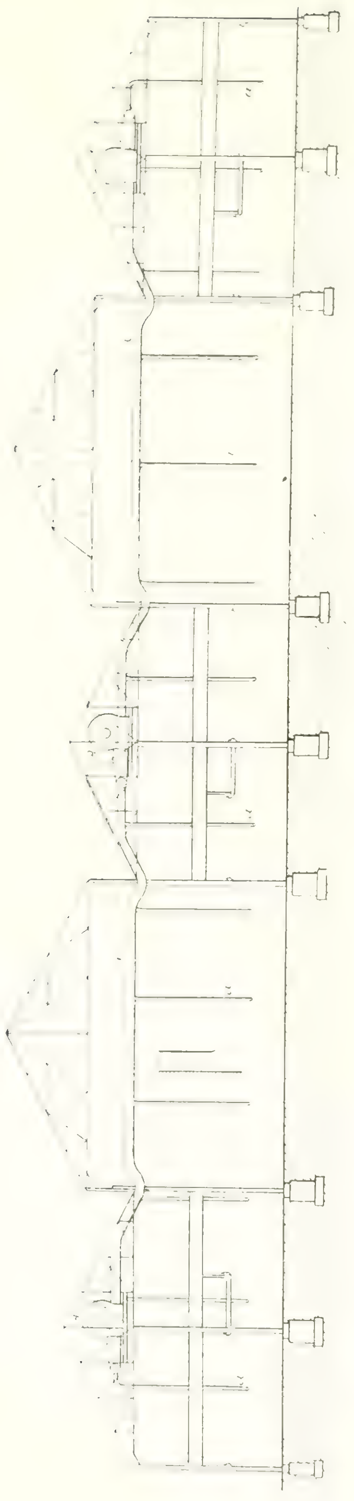


FIG. 2. END ELEVATION, BRITISH WESTINGHOUSE WORKS, SHOWING FANS IN POSITION IN ROOF TRUSSES, AND THE VERTICAL AIR PIPES.

patented by Messrs. Musgrave and Co., Ltd., of Belfast, the air is warmed by a stove in the base, and is thence distributed to the floors above. Fresh air flues lead in from the outside of the building, and the heated air is conveyed to the rooms above through earthenware pipes, or brickwork, or in iron pipes properly insulated.

VENTILATING FANS IN WALLS.

Another method is that of ventilating fans fixed in walls, driven either by belts, small, self-contained engines, or electric motors. These are admirable for certain classes of buildings and shops of moderate size, but they are not so well adapted to large works, nor do they touch the problem of heating.

SYSTEMS THAT COMBINE VENTILATION WITH HEATING.

The employment of open windows, louvres, ventilators, hot-water pipes, and fans is alike open to the objection that these require a good deal of attention to secure even an approximation to the adjustments of temperature. They involve, moreover, the adoption of two separate systems, when ventilating and heating, or cooling, should properly be united in one. The foregoing devices, though suitable for small shops, and for offices, fail to meet the conditions of the largest works. No big works should now be built without provision both for changing the air and warming it in winter, together with the necessary means of regulation. That these two matters have generally been separated, both in thought and fact, and have been considered as distinct for so long, is a striking commentary on the conservative attitude of mind.

But it is clear that such a combined system does not offer such simple problems for solution as the others do. A good deal of expert knowledge has to be brought to bear upon it. The problem is not merely that of supplying a specific amount of heat to a shop, but also that of supplying sufficient to compensate for the escaping heat which passes away with the air to the colder atmosphere without, and of that which enters from without through doors, windows, and roof. Means also have to be adopted for directing the currents of air equably through large buildings.

The best systems of combined ventilation and heating are those which are effected by

The Laying Out of Engineers' Workshops.

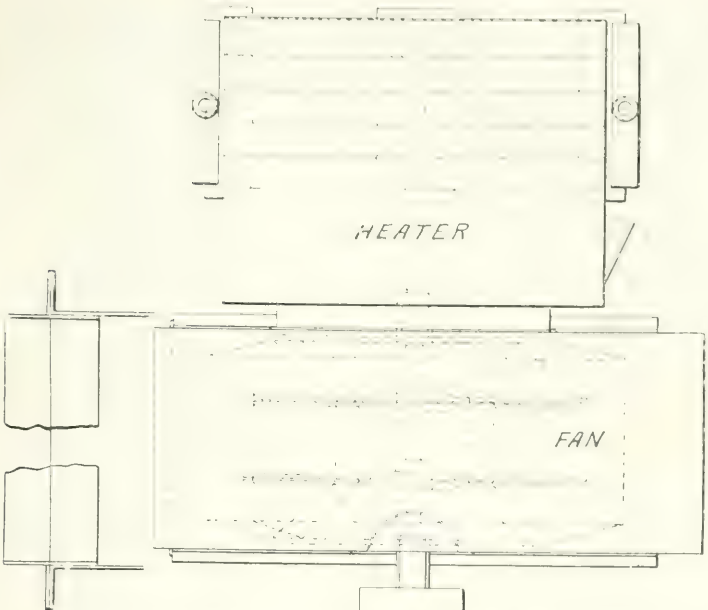
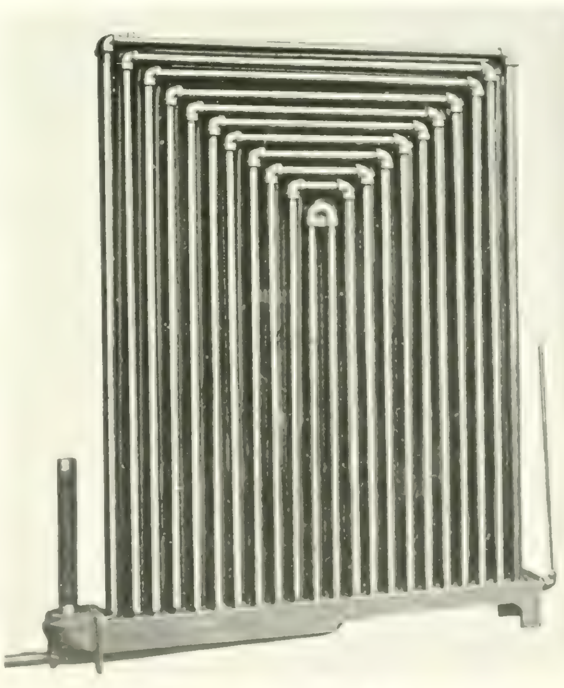


FIG. 3. OUTLINE PLAN OF BUFFALO FAN AND HEATER AT BRITISH WESTINGHOUSE WORKS.

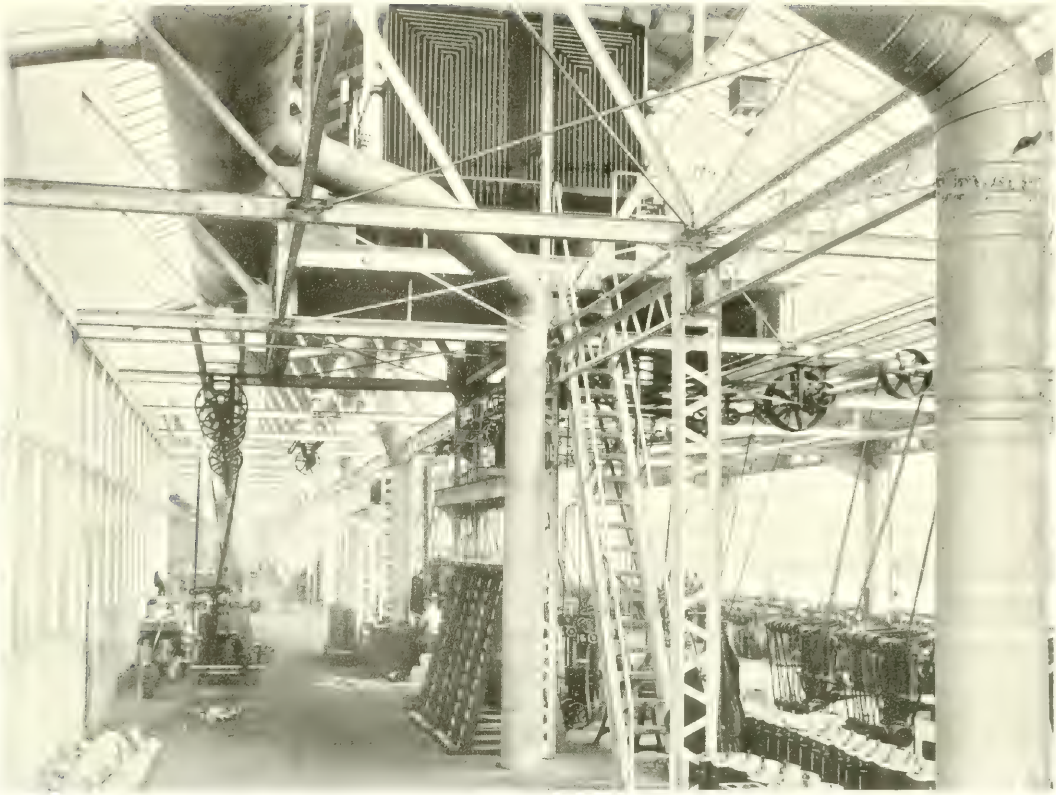
means of fans, heaters and pipes. In these the air is drawn into the building through heaters, warmed either by exhaust or live steam, and distributed under pressure through pipes or ducts having suitable outlets in the shops. The advantages of such a system are that the heater or heaters can be situated centrally in the basement of the building, that the air supply and the temperature are under perfect control, that the temperature is capable of regulation for different rooms, that draughts are nearly eliminated, and that any required volume of pure air can be supplied. It is independent of the state of the outside atmosphere, since the pressure and the temperature of the air are capable of regulation. Instead of cold draughts of incoming air, a warm current under equable pressure and in positive volume is distributed by the pipes and ducts at regular intervals. It has the great advantage of combining ventilation with heating, which the older systems of heating apparatus do not, or, at least, in a very slight and uncertain degree. The heating is started more rapidly than by hot-water pipes, or a central stove system, which seldom effect any appreciable alteration in temperature until breakfast time. A building can be warmed as readily in the coldest weather as in moderately cold conditions, and all is under absolute control. In a fan system, the incoming air can be either warmed, moistened, or filtered. Being forced under pressure into the shops, its pressure causes the expulsion of the impure air, either through flues, or through doors and windows, the latter generally sufficing in large works.

Incidentally, too, the installation of such a system lends itself to subsidiary benefits in the works, as the drawing away of dust from emery wheels, smiths' forges, saws, and wood-working machines, and of fumes from chemical baths. It is, therefore, absolutely certain that a few years will see immense extensions of this system in engineers' works.

In systems of this kind the heater comprises a large number of small tubes, about 1 in.



AN INDEPENDENT "SECTION" OF A [illegible] HEATER.



VIEW IN GALLERY OF BRITISH WESTINGHOUSE WORKS, SHOWING ARRANGEMENT OF BUFFALO PIPES.

in diameter, built up in sections on a suitable series of chambers, which permit of the circulation of steam, that warms the air passed among the tubes at a high rate, say about 1,200 ft. a minute. The efficiency, as compared with stagnant air in contact with hot water pipes, is evident, with a corresponding reduction in the area of the heating surface—about one-fifth at the above rate of transmission.

In an engineers' factory, as already remarked, the areas are largely in excess of those which are required on the basis of 250 cubic feet of air per man. Here, therefore, the question of heating is of primary importance, and ventilation becomes subsidiary. That is, the area required for heating exceeds that wanted for ventilation simply.

THE BUFFALO SYSTEM AT THE BRITISH WESTINGHOUSE WORKS.

Probably, the biggest installation of the kind in this country is that at the British Westinghouse Works at Manchester, which we are able to illustrate by the courtesy of the Buffalo Forge Company, of Buffalo, N.Y., and 39, Victoria Street, S.W., who designed and supplied the plant. Another big works in which the Buffalo system has been installed is that of the Barrow-in-Furness shops of Messrs. Vickers, Sons, and Maxim, Ltd. This system is also in use in a very large number of works and public buildings in America.

The apparatus consists essentially of the following elements. A boiler, and steam heater coils, the latter being built up in sections, or units, enclosed in a casing of sheet steel, and connected with a fan, and with the air pipes which lead into various parts of the building and distribute the air. The fan draws fresh air from without over the steam-heating coils, or forces it over the coils, according to the system employed. When heated it is forced into the air pipes and discharged at a suitable height above the floor line in the shops to be

heated. The elements of the system, therefore, are the fan, the heater, with its sections, valves, etc., and means of returning the water of condensation to the boiler house, the distributing pipes, and the means for cutting out sections that are not wanted at certain seasons. These details are shown in the accompanying drawings as follows :—

THE GENERAL ARRANGEMENT.

Fig. 1 (*ante*) illustrates the general arrangement in plan, of the air piping through the main machine shop, with the eight separate "plants" comprised in this installation, all discharging air collectively, or independently into the closed system of galvanised iron pipe seen in the figure. Fig. 2 is an end elevation of the machine shop, showing the plants in position up in the roof trusses, and the vertical air pipes or ducts. Fig. 3 is an enlarged outline plan of one of the plants, comprising fan and heater. Fig. 4 is an outline elevation of a fan on a larger scale. Figs. 5 and 6 show the connection of a fan to the pipes. Fig. 7 illustrates the details of ducts.

DETAILS.

Coming into details, the machine shop, fig. 1, which is of immense size, measuring 900 ft. long, by 320 ft. in width, and has a content of 21,870,000 cubic feet, is heated, as we just remarked by eight plants, all practically alike (fig. 3), discharging air into the closed systems of galvanised iron pipe located as shown. The eight plants can displace all the air in the building every forty-five minutes, that is to say, the fans together will handle 486,000 cubic feet of air per minute, or each fan will control 60,800 cubic feet per minute. The plants are located on the platforms provided in the tops of the buildings within the roof trusses (fig. 2). Three of these are placed in each of the outside bays, and two in the central bay (fig. 1).

The following brief account of the items in the plant will apply to each of the eight.

FANS.

Each fan (fig. 4), has a blast wheel, 8 ft. 10 in. in diameter, by 4 ft. $5\frac{1}{2}$ in. wide (fig. 3), passing 60,800 cubic feet of air per minute, when running

MAIN AISLE IN THE MACHINE SHOP OF THE BRITISH WESTINGHOUSE WORKS.

The vertical ventilating pipes can be seen alongside the columns.

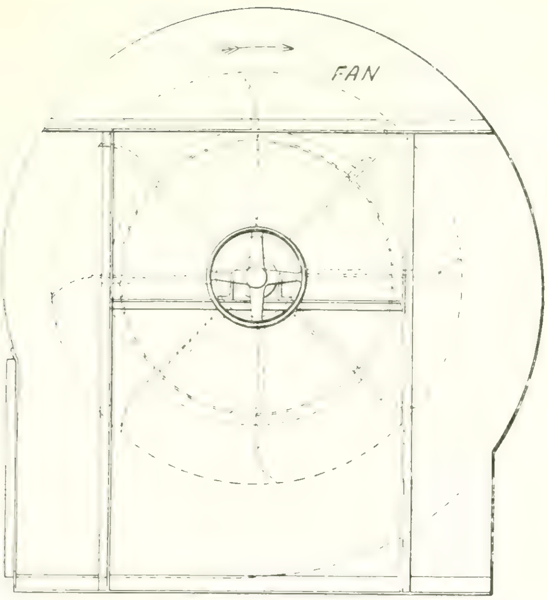
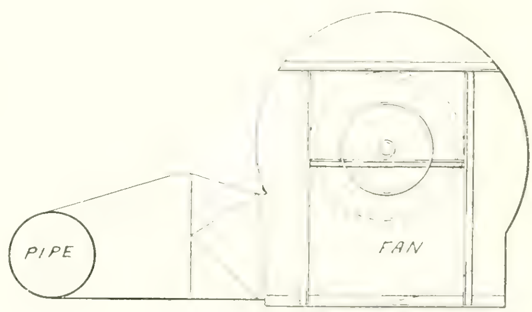


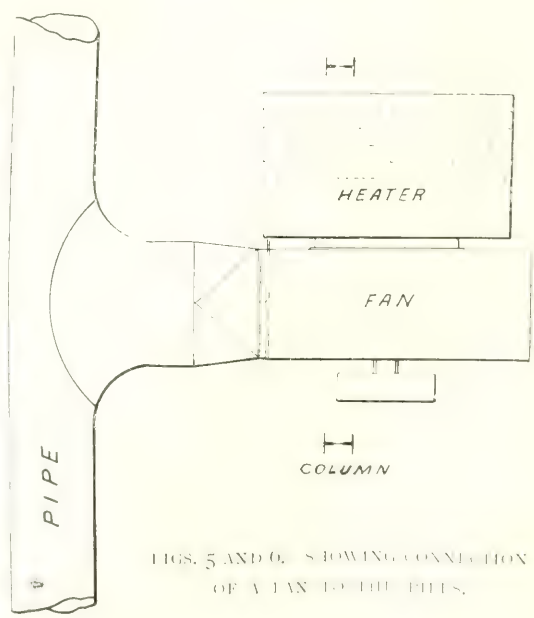
FIG. 4. OUTLINE ELEVATION OF FAN.

at 200 revolutions per minute. At this speed it absorbs about 30 b.h.p. These wheels are carried by shafts 4 in. in diameter, running in self-aligning chain oiling bearings, 4 in. in diameter, by 13¾ in. long, each bearing carried by heavy angle iron girders fastened to the side plates of the housing, and to vertical supports. The wheels are constructed on a double T iron spider, with heavy cast iron hubs. The wings are of the curved pattern (fig. 4), of No. 10 gauge steel, reinforced by flanges of similar gauge, and further strengthened by flat iron rings on the circumference, and angle iron rings at the inlets. Each fan is provided with a pulley belt driven from its own motor, the latter being of 40 h.p. 400 volt, polyphase, Westinghouse make.

HEATERS.

The heater (compare fig. 3 with photo on the same page) consists of ten independent four-row sections, each section being 5 ft. long, 7 ft. 4 in. high, and 8 in. wide, each section mounting four staggered rows of piping of 1-in. inside diameter. The complete heater for each of the eight plants contains 7,000 linear feet of 1-in. pipe. These sections were tested to hydraulic pressure of 150 lb. per square inch. The ten independent sections are placed in two batteries of five each, set back to back. An important detail is, that each independent section has its own steam and drip connection, both with the steam receiver and the drip header, which permits any section or any number of the sections to be cut out of use without affecting the utility of the remaining ones. The water of condensation from these heaters is returned to the boiler-house by the Warren Webster Vacuum system, in which a vacuum pump is employed. Multiple thermostatic valves by this firm are used, being designated by units. A 5-unit valve is placed on the heater with which the air comes into contact first, a 4-unit valve on the next, a 3-unit on the next, a 2-unit on the next, and a 2-unit on the next.





FIGS. 5 AND 6. SHOWING CONNECTION OF A FAN TO THE PIPES.

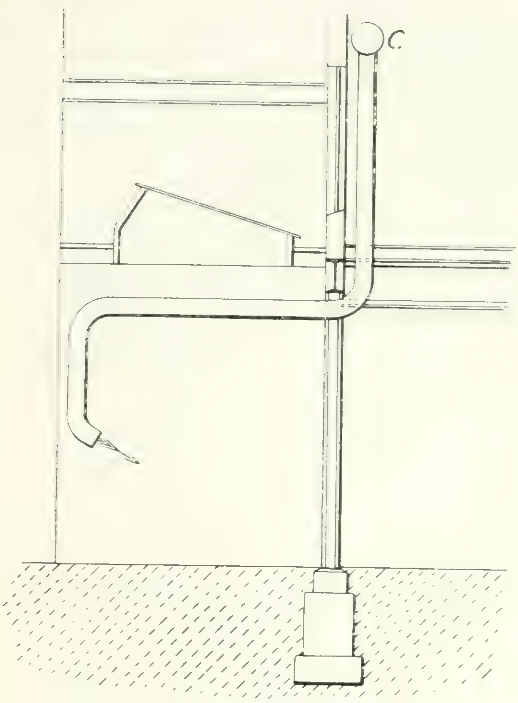


FIG. 7. SHOWING DETAILS OF DUCTS.

In the plan view of the arrangement (fig. 1) the fans are indicated at A, the heaters at B, while the steam and return pipes are denoted by lettering adjacent to each respectively. The air is drawn through the steam-warmed heater by the action of the fan adjacent, and sent on through the main pipes C, and distributed thence through the discharge tubes, *a*, into the shop.

This system of pipes, which looks rather lost on the general drawing, is really a very big one. The largest sizes next the fans are 42 in. in diameter, whence they become reduced in size to 32 in. and 30 in. The large discharge tubes, D, are 18 in., the smaller ones, 8 in. to 10 in. diameter. There are several features in connection with these pipes that should be noticed. The pipes are made of galvanised iron of different gauges suitable to their diameters, so that lightness is secured. All pipes of 8 in. to 10 in. diameter are of No. 26 galvanised iron gauge; those of 13 in. to 18 in. are of 24 gauge; 19 in. to 24 in., 23; 25 in. to 30 in., 22; 31 in. to 40 in., 20; 41 in. to 50 in., 18; and those of 50 in. and over are of 16 gauge. The branch pipes and the discharge tubes leave the main pipe with conical connections, one of which is shown enlarged in fig. 6. The result is that no impediment is offered to the passage of the air in either direction.

The pipes, C, extend from the heating plant placed on the platforms overhead (fig. 2), and run in both directions through the entire length of the machine shop between the openings in the roof trusses down to the outside, and the central bays (fig. 1). At every other girder, or, what is the same thing, at every 32 ft. along the entire length of the two outside and central bays, the downcomers, *a*, are placed, extending to within 12 ft. of the ground line. These pipes are 18 in. in diameter, and form a Y at the end, having two 15-in. discharge pipes. Along the front and rear walls of the shop, at about every 32 ft., are placed similar downcomers. The heating and ventilation of the first floor on the two outside and central bays is provided for by short tubes at about every 32 ft. Each discharge tube is provided with an adjustable volume-regulating damper to control the supply of air at every point of discharge.

The Buffalo Company have also constructed plants for the Box Factory, Pattern Shop, and Foundry Stores of the Westinghouse Works, the plants being of similar design to that in the machine shop, and modified only to suit the purpose and lay out of each shop. It may be noted that the air is changed every twenty-five minutes in the foundry store, every twenty-five minutes in the pattern shop, and every twenty minutes in the box factory.

Photo by the Author.

FIG. 10. SLIMES PLANT AT THE CITY AND SUBURBAN MINE, OF SIMILAR CONSTRUCTION TO THAT AT THE ROBINSON MINE, SHOWING HOW THE TREATED SLIMES ARE DISCHARGED BY HYDRAULICING.

THE EQUIPMENT OF THE ROBINSON MINE JOHANNESBURG.

BY

EDGAR SMART, A.M.INST.C.E.

A description, with specially taken photos, of one of the oldest and largest of the outcrop mines on the Rand. The previous article described the incline shafts, main power plant, mill, water regulation, etc. The present instalment is concerned with the cyanide plant and chlorination works. A further article will complete the survey.—ED.

II.

CONCENTRATION.

THE practice of subjecting the whole of the mill pulp to close concentration by Frue vanners, which was so largely adopted on the Rand up to 1895, has been gradually abandoned in favour of rough concentration by spitzlutten, but at the Robinson mine and a few others, the vanners are still used for producing rich concentrates suitable for chlorination. When all the pulp is sent to the vanners, three of these are necessary to deal with the product of each five heads. At the Robinson mill the pulp from 70 stamps is still treated in this way on 42 vanners originally erected for that purpose. But from the rest of the mill the pulp is passed through spitzlutten, and the underflow from these containing a roughly concentrated product of much smaller bulk is divided between the 42 vanners above mentioned. Otherwise 78 extra vanners would be required, so that this method means a considerable saving in first cost, although, of course, the percentage of pyrites recovered is less than it would be with the larger number of vanners. The quantity of concentrates now being produced amounts to approximately 2 per cent. of the total pulp, and their average value is 3½ oz. per ton, which shows that the vanners take out about 1·4 dwt. fine gold per ton of crushed rock.

Table III., compiled from the published reports of the company, gives particulars of the concentrates during the period when three vanners were used for each five stamps, and the ratio of pyritic to oxidised ore was constantly increasing.

TABLE III.

RESULTS OF CLOSE CONCENTRATION.

Year.	Percentage of Pyritic Ore sent to Mill.	Percentage of Concentrates Produced.	Value per ton of Concentrates	Value per ton of Ore.
			oz.	dwts.
1891	12·48	1·73	4·78	1·7
1892	56	2·18	3·82	1·67
1893	85	2·86	3·93	2·25
1894	100	2·80	4·74	2·67
1895	100	2·63	4·04	2·13

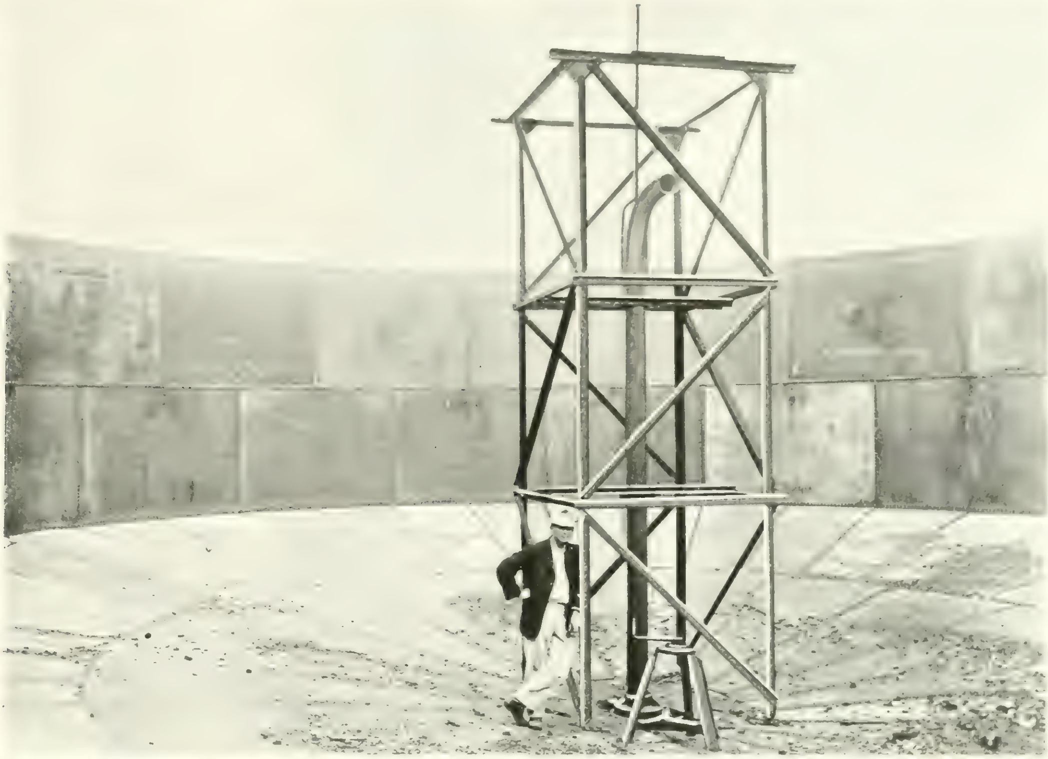


Photo by the Author.]

FIG. 8. ROBINSON SLIME PLANT.—INTERIOR VIEW OF ONE OF THE SLIME-SETTLING TANKS IN COURSE OF CONSTRUCTION.

It is 50 ft. in diameter and 12 ft. deep.

CYANIDE PLANT.

In the early nineties, upon the advice of the consulting engineer, Mr. Hennen Jennings, this company became the pioneer in the application of metallurgical processes to the re-treatment of the Rand banket after it had undergone the usual treatment by crushing and amalgamating. It was the first company to use the cyanide process for tailings on a commercial scale, after the treatment of 10,000 tons by the MacArthur Forrest Company had shown that the Robinson tailings could be treated at a profit. A plant for dealing with 8,000 tons of sand per month was designed by Mr. Charles Butters, and built by the author in 1891, which included twelve timber leaching vats, 20 ft. in diameter, having 8-ft. staves, built upon stone piers, and fitted with bottom discharge doors. These vats were built of Baltic deals, and the fact that they are still in use at the present time shows that when constructed of well-selected material, wooden vats have a considerable length of life. This plant has been extended by the addition of new vats which have been necessary from time to time to keep pace with the increase in the crushing power of the mill. The latest addition, now in course of construction, includes five pairs of 400-ton steel vats, built in double tiers on steel girders, and cast iron columns. Owing to these successive and necessarily irregular additions, the present sand treatment plant is naturally less compact and systematic than other large works which have been designed and built more recently, and therefore it is not worth while to give a detailed account of it. If, however, its sand plant is somewhat below par, the Robinson Company's slime plant now in course of construction, is quite up to date, and embodies all the latest methods which have been applied so far to the treatment of current slimes.

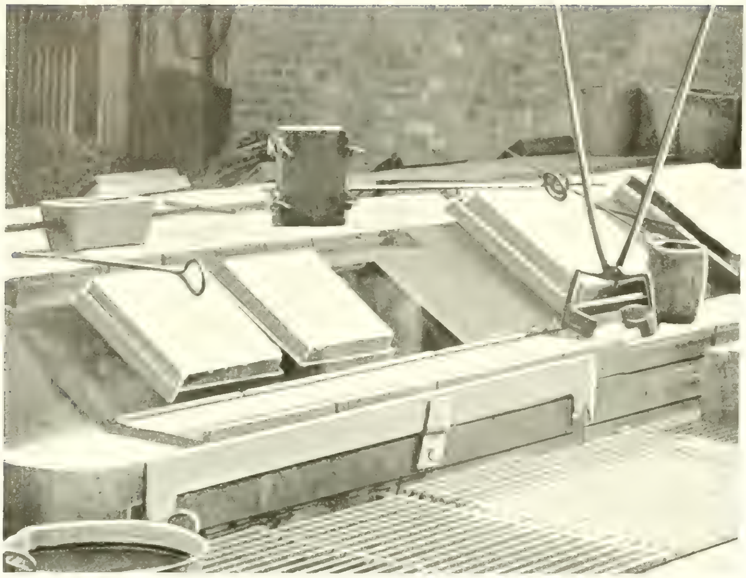


Photo by the Author

FIG. 9. ROBINSON MINE, JOHANNESBURG—POT FURNACES IN THE SMELTING ROOM.

All the cyanide treatment work, whether for sands or slimes, is under the management of Mr. G. A. Darling, who had charge of the first cyanide plant on the mine, and has remained on the staff of the company since 1890.

THE NEW SLIME PLANT.

The construction of this is being carried out under the direction of Mr. Aimetti, who kindly supplied the following particulars of the plant as it will be, when finished, according to the designs of the consulting engineers of the company, Mr. Sidney Jennings and Mr. J. G. Poore.

The most striking feature of all the most recent slime plants on these fields is the large size of the vats, which will be realised from an inspection of the photographs, especially from fig. 8. In this case there are ten steel vats, each of which is 50 ft. in diameter and 12 ft. deep at the sides, while the bottom is dished conically to a further depth of 3 ft. 9 in. at the centre.

The vats are placed in three parallel rows; two rows with three vats in each are built on the surface level at the site, while the four vats in the third row are placed 11 ft. higher on an embankment enclosed by dry stone retaining walls at both sides and ends. In each case the ground under the vat is formed to the shape of a hollow cone to fit the dished bottom, which rests upon a layer of asphalt to protect the steel from rusting.

There is a 10-in. hole in the bottom of each tank, and the discharge pipe from this is carried out under the vat in a brick-lined tunnel, so that it is always readily accessible. The discharge hole is closed when necessary by means of a rubber-covered annular valve plate attached to the lower end of a vertical pipe suspended by a forked rod and chain from a hand winch on the staging above the vat. This valve plate has taper feathers projecting downwards, which enter the discharge hole when the pipe is lowered to ensure the true seating of the valve.

A neat braced standard, built of light angle irons, is fixed in the middle of each vat to carry the staging and gangways, as shown in the interior view (fig. 8), which also clearly shows the forked rod and vertical pipe referred to above. The bend at the top of the latter is provided so that a hose may be attached thereto, if necessary, and a stream of water sent through the vertical pipe and bottom valve to clear away any obstruction in the discharge pipe, which remains open to the vertical pipe when closed to the vat, because the valve plate is annular, as above mentioned, and not solid.

The four upper vats are provided with a peripheral overflow trough, which is carried round the whole circumference, and has a slight downward grade towards the discharging point, in both directions round the circle.

The staging is constructed of timber, with the exception of the iron standards already mentioned, and it is arranged so as to give convenient access to all the valves, nozzles, etc. It includes two main gangways, extending lengthwise between the rows of vats, with smaller cross gangways from these to the centre standards

of the vats; upon these latter, immediately above the standards the small winches are placed to operate the bottom discharge valves. There are also two other cross gangways connecting the two main ones so that no time is wasted in getting from one part of the plant to another.

The following motors and pumps will be installed for dealing with the slimes :—

Two 50-h.p. electric motors, at 415 revolutions per minute.

One 30-h.p. electric motor, at 590 revolutions per minute.

Two 10-in. Morris special slime pumps, lined with manganese steel.

One 6-in. high lift Sulzer centrifugal, capable of lifting 11.000 gallons per hour against a head of 100 ft.

One 6-in. high lift Sulzer, capable of delivering 7,000 gallons per hour 100 ft. high against the frictional head due to 1,400 ft. of 6-in. pipe.

SLIME TREATMENT.

The following is a general outline of the treatment given in plants of this type, and which will be introduced at the Robinson Company when the plant is completed. After the sands and slimes have been separated in the usual manner by collecting vats and spitzlutten at the cyanide plant, the slimes and the water remaining with them are pumped up through a 16-in. pipe to a launder passing over the four upper vats of the slimes plant, into one of which the flow is directed. Owing to the large diameter of the vat, the slimes settle very rapidly and completely, and from the time the vat is full of liquid, the water overflowing into the peripheral trough is quite clear, and is sent back immediately to the mill through another 16-in. pipe.

When sufficient slime has deposited in No. 1 vat, the flow is diverted into No. 2, and so on in succession. The clear water still remaining above the settled slime in No. 1 is run off through a decanting pipe, which is hinged near the bottom, so that its upper end descends as the level of the water is lowered, and its mouth is always just below the water surface. When this operation is completed the charge of wet slime is ready for cyanide treatment.

A very diluted solution of KCy is delivered into the vat through a 6-in. pipe, then the bottom valve is opened, and the contents are drawn off by a 10-in. centrifugal pump: and transferred thereby into one of the six lower vats at a considerable pressure through a side pipe so placed

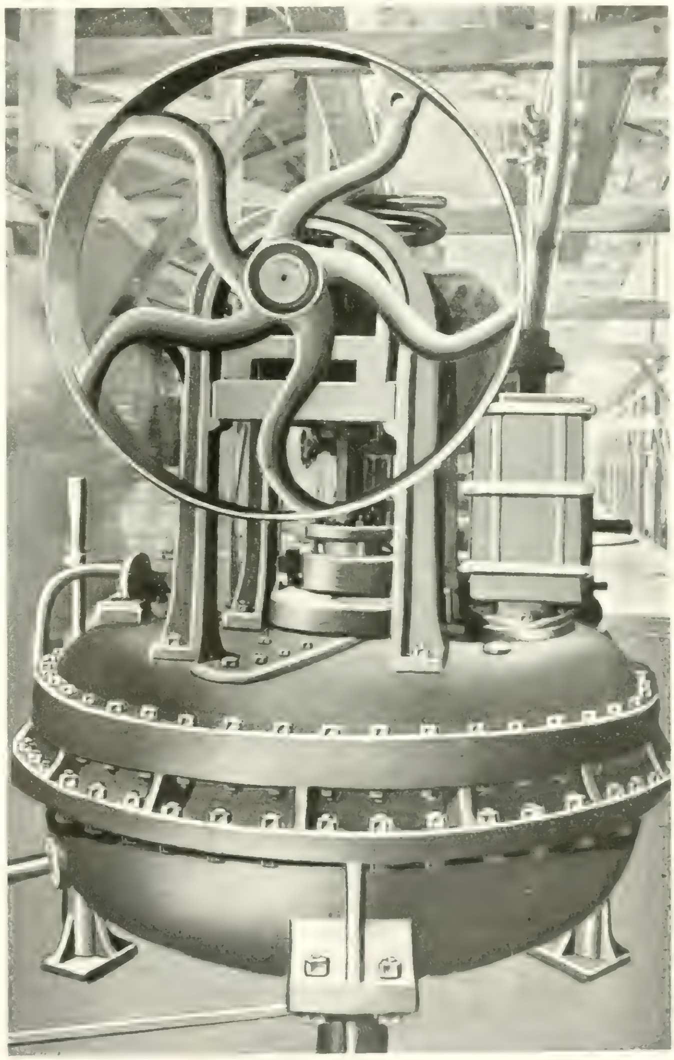


FIG. 11. BUTTERS' PATENT CHLORINE GENERATOR, AT WORK AT THE ROBINSON MINE.

that the inflowing stream has a direction nearly tangential to the circle of the vat. This causes a rotating motion in the liquid, with the object of keeping the whole mixture well stirred up. As soon as the transfer is completed, the bottom valve is opened, and the pulp is drawn off by a centrifugal, which continually delivers it again into the same vat at the top thereof, thus keeping up a continuous circulation. This pump is kept at work and supplied with compressed air to aerate the solution until the gold is dissolved. After this the valve is closed, and the slime allowed to settle; the clear solution is run off to the precipitation boxes through a 16-in. decanting pipe. The settled slime is then hydrauliced out by a nozzle jet of water from a $3\frac{1}{2}$-in. hose, and is carried by a 16-in. pipe, laid at a 3 per cent. grade, to the slime dams. If the values originally in the slime are sufficiently high to warrant additional handling, a second treatment with cyanide solution is given before the material is finally discharged. Fig. 10 illustrates the sluicing out operation and also the appearance of a finished slime plant of the same type.

THE CHLORINATION WORKS.

These form a special feature of interest in the equipment of this mine, not only because they were the first successful chlorination works erected on the Rand, but also because this is the only mine on which the process is practised at the present time. The Simmer and Jack mine put up a small plant in 1894, which is now shut down, and three other plants have been erected at various times, by several metallurgical companies for the treatment of purchased concentrates, but of these latter, also, only one is still in operation.

This retrogression as regards the use of chlorine is not due to any technical failure of the process, which, on the contrary, gives admittedly a far higher extraction of gold from Rand concentrates than any other method. The reasons are purely financial, and may be briefly stated in the following manner: The pyritic product in all cases amounts to only a small percentage of the rock crushed, so that if each mine chlorinated its own concentrates, only a small plant would be needed in each case, and the cost of treatment would consequently be heavy; the choice, therefore, remains between selling to Customs works at a price which leaves a profit to the latter, or making a rough concentrate by means of spitzlutten for treatment by cyanide. At one time a large number of mines adopted the first-named alternative, hence the building of several Customs works, but latterly the majority of mines have abandoned close concentration and adopted the second alternative.

The introduction of the process in this district was due to the recommendation of Mr. Hennen Jennings in 1891, and the first instalment of the plant was designed by Mr. Charles Butters, and erected under his supervision by Mr. A. Bradley and the author. Since that date it has been considerably enlarged, and the author's best thanks are due to the present manager of the plant, Mr. J. J. Lambe, who has kindly placed at his disposal the fullest information concerning the present plant and methods of working.

THE FURNACES.

The three furnaces first built, and which are still in operation, have hearths 60 ft. long by 14 ft. wide inside, with a step 12 in. deep at a distance of 20 ft. from the fire bridge, the lower front portion constituting the "finishing" hearth. The two furnaces of later construction have generally the same dimensions, but the finishing hearth in these is 18 ft. long by 16 ft. wide instead of 20 ft. by 14 ft.

The side walls are 18 in. thick, and the arched roof 9 in., the latter being built with wedge-shaped bricks to a segmental curve, having about 1 in. rise per foot of span. Second-hand 40-lb. rails are built in flush with the outside faces of the side walls, following the line of the skewbacks. Vertical channel irons are used to stay the walls, and these are held together by $1\frac{1}{8}$-in. bolts passing across the furnace, both below the hearth and above the arch. The space above the haunches of the arched roof is filled up to form a flat floor, which is bricked over to form a drying floor when required for moist unroasted material. The working doors are spaced at 5-ft. centres on both sides of the furnace.

The fire box is placed at the extreme end of each furnace; the fire bars rest on a pair of

inclined cast-iron bearers, which slope down at an angle of 45 deg. towards the fire bridge, so that the arrangement is similar to a flight of steps. The spaces between the bars serve for the purpose of raking and cleaning the fires, and there is also a small horizontal grate with ordinary fire-bars running crosswise of the furnace, with side doors for the same purpose. This horizontal grate occupies the space between the foot of the inclined bearers above mentioned and the fire bridge. The top of each fire box is formed by a cast plate, having one central circular feed door, 12 in. in diameter for shovelling in the fuel. The coal is contained in a bunker built on columns immediately in front of the firebox; each bunker is large enough to contain 6 tons of coal, equal to three days' supply.

Castings containing circular discharge orifices 10 in. in diameter are built into the finishing hearth, having cast covers which lie flush with the surface, and a tunnel is formed under them large enough to allow trucks of 20 cubic feet capacity to enter. In the second and third furnaces four such doors are spaced at 5-ft. centres along the centre line, and the tunnel runs in lengthwise under the firebox. In the other three furnaces there are only three doors in each, placed in line over a tunnel which passes crosswise through the furnace. By the first-named method, the tunnel is a *cul-de-sac*, so each set of full trucks has to be pulled out before a fresh set of empties can be run in, while in the second case the trucks can follow one another through in succession. Nevertheless, Mr. Lambe prefers the first plan because the material can in that case be pushed straight across from the working doors to the discharge holes in less than ten minutes, while in the second case it has to be worked up from each end of the hearth to the line of discharge doors, and this requires about half an hour.

Each furnace is provided at the back end with a dust chamber 12 ft. long by 14 ft. wide. A number of cross walls are built in this chamber which start alternately from each of the side walls and extend across about three-quarters of the width of the chamber, so that the products of combustion have to pass in a zig-zag course between these walls on their way to the shaft. Consequently, most of the fine ore dust carried off by the draught is deposited in the chamber, and is cleaned out from time to time through doors in the side walls.

CHIMNEY STACKS.

These are all built of steel plate with $4\frac{1}{2}$-in. brick lining. No. 3 furnace has a stack 3 ft. 9 in. clear inside diameter, and about 80 ft. high. The other four are connected in pairs to two stacks of the same height, the diameter of the steel tube being 6 ft. 6 in., giving 5 ft. clear inside the lining. The tube is composed of 7-ft. by 4-ft. plates, the lowest 24-ft. is $\frac{5}{16}$ in. thick, the next 28-ft. is $\frac{1}{4}$ in., and the top part $\frac{3}{16}$ in.

The cost of such a stack in Johannesburg is made up as follows :—

16,590 lb. steel plate @ 15s. 3d. per 100	£126	10	0
6,000 bricks @ £5 per 1,000 ..	30	0	0
Boiler makers' labour	75	0	0
Labour for erection and lining ..	124	10	0
Total ..	£356	0	0

(To be continued.)

LARGE POWER-GAS ENGINES.

BY

EDWARD BUTLER, M.I.MECH.E., ETC.

*The advances made in connection with the more economical utilisation of blast-furnace-gas have greatly increased the possibilities of large gas engines, more particularly in generating stations. Mr. Butler here presents a careful summary of the various types, showing the points of essential difference, and discussing some possible future improvements.—*Ed.

AT the time of the 1889 Paris Exhibition, the 100-b.h.p. horizontal single-cylinder engine made and exhibited by the Sté Ame Powell, of Rouen, was considered an engine of colossal size, and excited a great amount of interest among engineers and manufacturers generally; it being then the largest gas engine the world had seen.

Explosion engines have since that time been taken in hand by manufacturers capable of dealing with engines of enormous size, in whose construction are parts that may separately weigh as much as the complete 100-h.p. engine which was then such a giant among the various makes of engines of this class.

An engine of similar design, constructed on the same general lines and known as on the Delamere-Deboutville System, was shown at work during the exhibition of 1900; this engine was capable of developing 1,000 b.h.p. on illuminating-gas, and was intended for use with the waste furnace-gas of iron and steel works. This enormous engine was made and exhibited by the Sté Ame John Cockerill, of Seraing, Belgium, who have done more in the last six years in forcing the growth of the gas engine than any other manufacturer. Both these engines were built on the simple four-cycle movement with one single-acting open-ended cylinder, very closely following the lines of the ordinary Otto gas engine of small power. Other manufacturers have turned their attention to the construction of large power engines, the chief incentive to the surprising enterprise exhibited in this direction being the more profitable utilisation of coke-oven and smelting-furnace gases, than was possible under the most efficient system of steam generators and engines.

TREATMENT OF THE FURNACE-GAS.

Great credit is due to the researches and experiments of Mr. B. H. Thwaite in this country, and to the Sté Cockerill on the Continent, in demonstrating the enhanced power value of the gases properly treated for combustion in the cylinder of the explosion engine. Many difficulties were experienced in separating the minute particles of floating ash and cinder from the immense volume of hot gases escaping from a series of high furnaces. The method very generally adopted is to pass the gas through a centrifugal extractor, by which process the

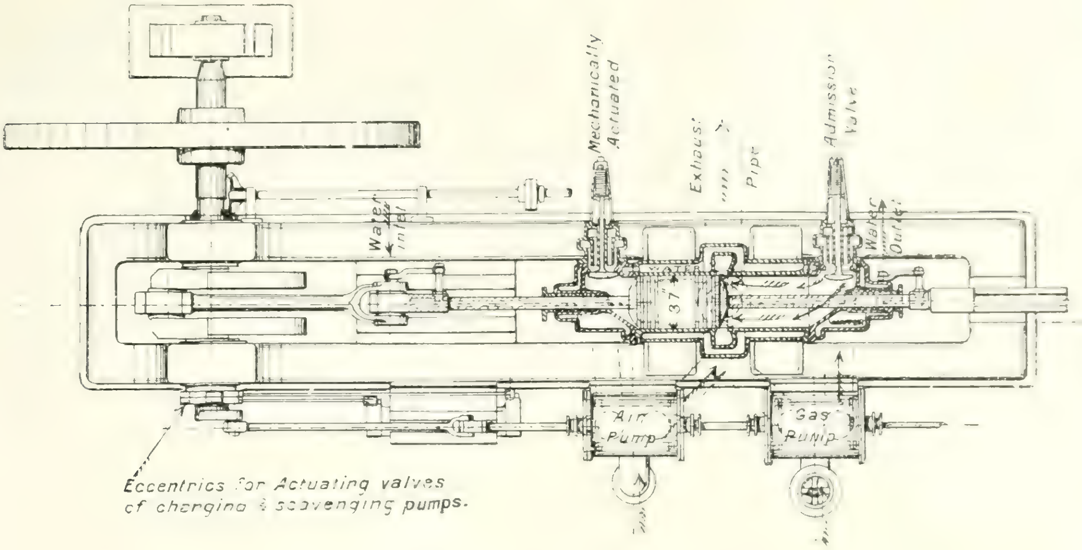


FIG. I. DOUBLE-ACTING KÖERTING 1,000-B.H.P. TWO-CYCLE FURNACE-GAS ENGINE.
Requiring no exhaust valves to the explosion cylinder.

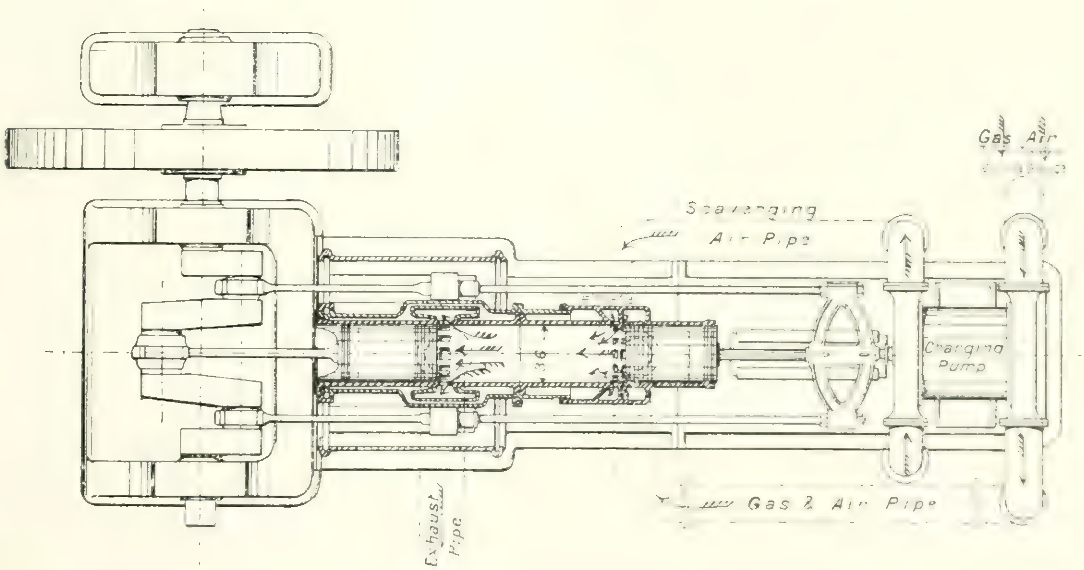


FIG. 2. BALANCED-ACTION 1,000-B.H.P. OECHELHAUSER TWO-CYCLE FURNACE-GAS ENGINE.
Requiring neither exhaust nor admission valves to the explosion cylinder.

dust is whirled out with such effect as to leave it practically free from impurities and ready for direct use in the engines.

TWO-CYCLE FURNACE GAS-ENGINES.

Köerting Brothers, of Hanover, and the Deutchen Kraft Gas Gesellschaft, of Berlin, have developed types of engines specially suited for use with the furnace-blowing engine; these engines both work on a modification of the Clerk two-cycle action; the Köerting being double-acting and closely resembling a horizontal steam-engine, while the other (or Oechelhauser) is built on the double-balanced piston system as in the old Sturgeon gas engine. These engines, unlike the small single acting engines on the two-cycle movement built before the expiration of the Otto patent, have two charging pumps, one for gas and one for air; and as the furnace-gas supplied to the engine is about equal to the necessary air, the pumps are approximately of the same capacity, except that the air pump is made large enough to blow a flushing current of cold air through the cylinder before the admission of the gas and air charge for combustion.

The Köerting engine (fig. 1) has a double-acting cylinder, fitted with a hollow water-cooled piston and rod passing through a metallic packed stuffing-box; a crosshead is connected to one crank, the pistons of the two charging cylinders being both worked from a small crank disc on one side of the shaft while the other end is extended to carry the flywheel.

The Oechelhauser engine has a long explosion cylinder, fitted with two pistons connected by one front and two side rods to a three-throw crank shaft; and as the cylinder is open at each end there are no piston-rods or packing-boxes to the explosion cylinder; the double-acting charging pump is worked tandem to the rear piston crosshead, and delivers a flushing current of cold air to the cylinder after each explosion in advance of the following charge of air and gas for combustion.

FOUR-CYCLE SINGLE-ACTING ENGINES.

Other makes of engines of the horizontal type adapted for comparative large powers are the double-cylinder engines of the Gas Motoren Fabrek, Deutz (fig. 3), Crossley Brothers and Andrews and Company, whose cylinders are arranged face-to-face with a single crank between, to which the two water-cooled pistons are connected by separate rods; there are thus no packing-boxes nor piston-rods.

The three-cylinder vertical Westinghouse engine may be cited as another instance of the open-ended single-acting cylinder type constructed with water-cooled pistons, each connected by its own separate rod to a three-throw crank shaft, and avoiding the use of packing-boxes and piston-rods. Single open-ended cylinder engines of large power requiring no packing-box nor piston-rod are made by Soest and Co., of Düsseldorf; also by the Nürnberg Company, the Deutz Company and the Cockerill Company, in sizes from 200 b.h.p. to 650 b.h.p. on furnace-gas.

The Premier Company now make a tandem single-acting double-cylinder type of engine, with the two pistons connected by a piston-rod which passes through the breach of the front cylinder whose piston is connected to the crank shaft. This engine formerly had its two pistons connected together by side rods, to avoid the packing-box and piston-rod, it being held by many makers that this method of construction was inimical to the development of the full explosion effect.

DIFFICULTIES IN PACKING THE RODS OF DOUBLE-ACTING ENGINES OVERCOME.

The comparative advantage of an engine working without the water-cooled piston-rod and packing-box is now proved to be less than it was deemed to be a few years ago, for engineers have solved the problem of passing the piston-rod through a metallic packed-box in the breach of the cylinder in such a manner as to wear efficiently under the conditions of heat and pressure obtaining in a modern explosion engine working at high compression. The difficulty has been overcome by using a long box efficiently cooled and packed with a series of wedge-shaped segmental rings, and kept properly lubricated.

The makes of engines in which this improvement is taken advantage of, in addition to the Köerting two-cycle engine, are the Nürnberg double-acting tandem engine by the Vereinigte

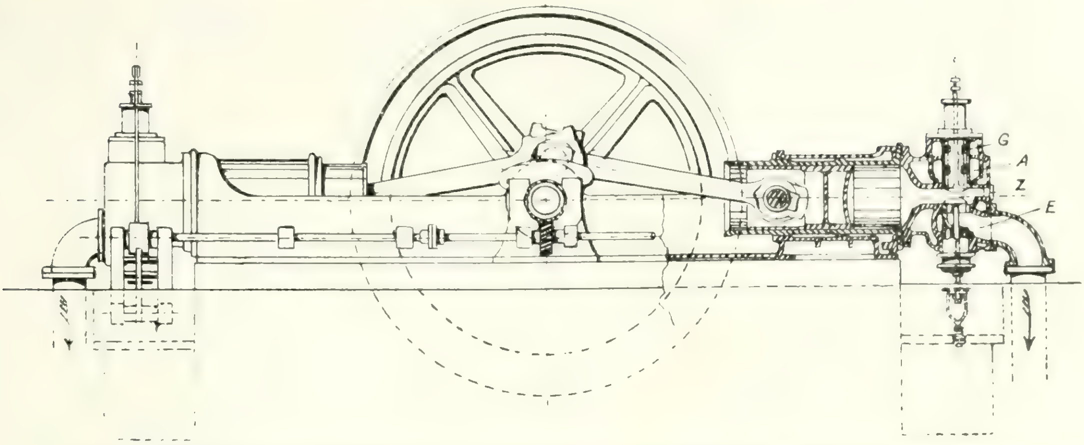


FIG. 3. DOUBLE-CYLINDER 500-B.H.P. DEUTZ OTTO ("VIS-A-VIS" TYPE) FURNACE-GAS ENGINE.

G, Gas ; A, Air ; E, Exhaust ; Z, Electric igniter.

Maschinenfabrik, Augsburg ; the Gas Motoren fabrik, Deutz ; the Letombe engine of Fives-Lille ; the Cockerill engine of Seraing ; and the Westinghouse engine ; all of which makers build for their largest powers units of horizontal tandem double-acting cylinder engines connected by one rod to a single crank. The weight of the pistons is carried by rigid hollow water-cooled rods passing through metallic packed water-cooled boxes, and rest on white metal-lined bearing slippers ; in this manner excessive wear of the rods, cylinders, and pistons due to the horizontal disposition of the moving parts is avoided. Two engines of this design are illustrated by figs. 5 and 8.

Each of the five horizontal tandem double-acting makes named, works on the four-cycle movement, and delivers an explosion impulse to the crank at every stroke just as would obtain in a single-cylinder double-acting steam engine. This arrangement, combined with the system of automatic speed regulation by large governors

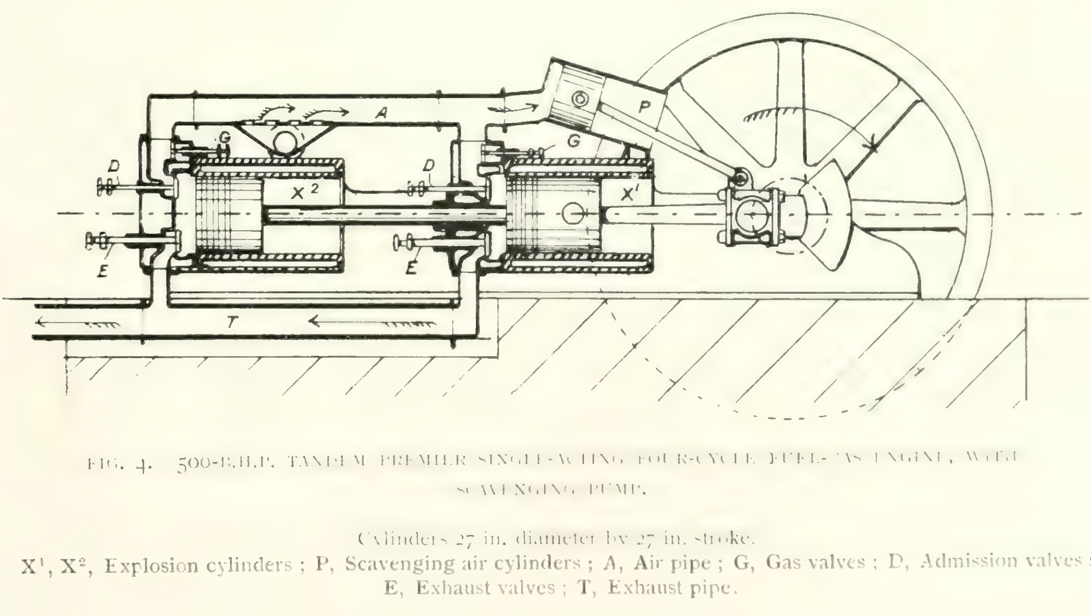


FIG. 4. 500-B.H.P. TANDEM PREMIER SINGLE-ACTING FOUR-CYCLE FUEL-GAS ENGINE, WITH SCAVENGING PUMP.

Cylinders 27 in. diameter by 27 in. stroke.

X^1, X^2, Explosion cylinders ; P, Scavenging air cylinders ; A, Air pipe ; G, Gas valves ; D, Admission valves ; E, Exhaust valves ; T, Exhaust pipe.

controlling the volume of gas and air supplied to the two ends of each cylinder at every induction stroke, ensures a degree of regularity of running comparable with the very best steam engines. So even is the working of these large gas engines that several coupled up direct with electric generators can be safely connected to run together in parallel, and there are instances where a large gas engine is coupled up with a large steam engine without giving trouble.

THROTTLE CUT-OFF METHOD OF GOVERNING.

This system of regulation by augmenting or diminishing the volume of gas and air is now generally adopted in all large gas engines: in some cases by an automatic cut-off and in others simply by throttles connected synchronously to the gas and air supplies; there is a slight advantage on the score of economy in using the trip-gear cut-off method, but as the necessary mechanism must be repeated for both ends of each cylinder, an ordinary balanced governor-controlled throttle is found to be sufficiently effective for all practical purposes.

ADVANTAGES OF THE DOUBLE-ACTING.

Now that the prejudice to the use of double-acting cylinders is dying out, makers who confine themselves to the construction of single-acting cylinders will find it hard to compete with the double-acting engine, which possesses the great advantage of double power capacity with the same height and width as the single-acting type, and only occupies from twenty to twenty-five per cent. increased length of space. This degree of comparison may also be applied to the increase in weight.

ESSENTIAL FEATURES FOR A CYLINDER OF LARGE POWER.

Generally speaking, the construction of an efficient gas engine cylinder for large power differs from the small engine in the necessity for water-cooling the piston and the exhaust-valve, whether the engine be single or double-acting; in providing duplicate electric igniters; in designing the cylinders so that the breach end joints will not be broken by the unequal expansion and contraction of the inner and outer walls.

DESCRIPTION OF THE TWO-CYCLE AND FOUR-CYCLE SYSTEMS.

In the sectional plan (fig. 1) a Köerting two-cycle blast-furnace-gas engine of 1,000 b.h.p. is illustrated diagrammatically to show all the essential working parts, including the

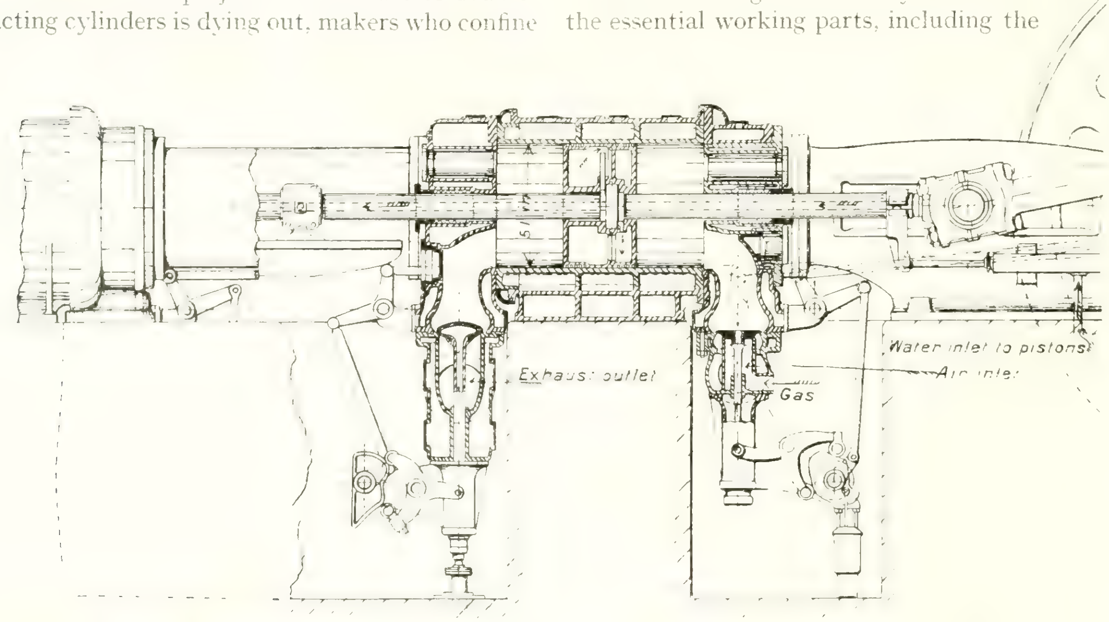


FIG. 5. FOUR-CYCLE ACTION TWO-CYLINDER TANDEM DOUBLE-ACTING FURNACE-GAS ENGINE. 2,500 b.h.p. Cockerill system. Cylinders: 51 in. diameter, 55 in. stroke.

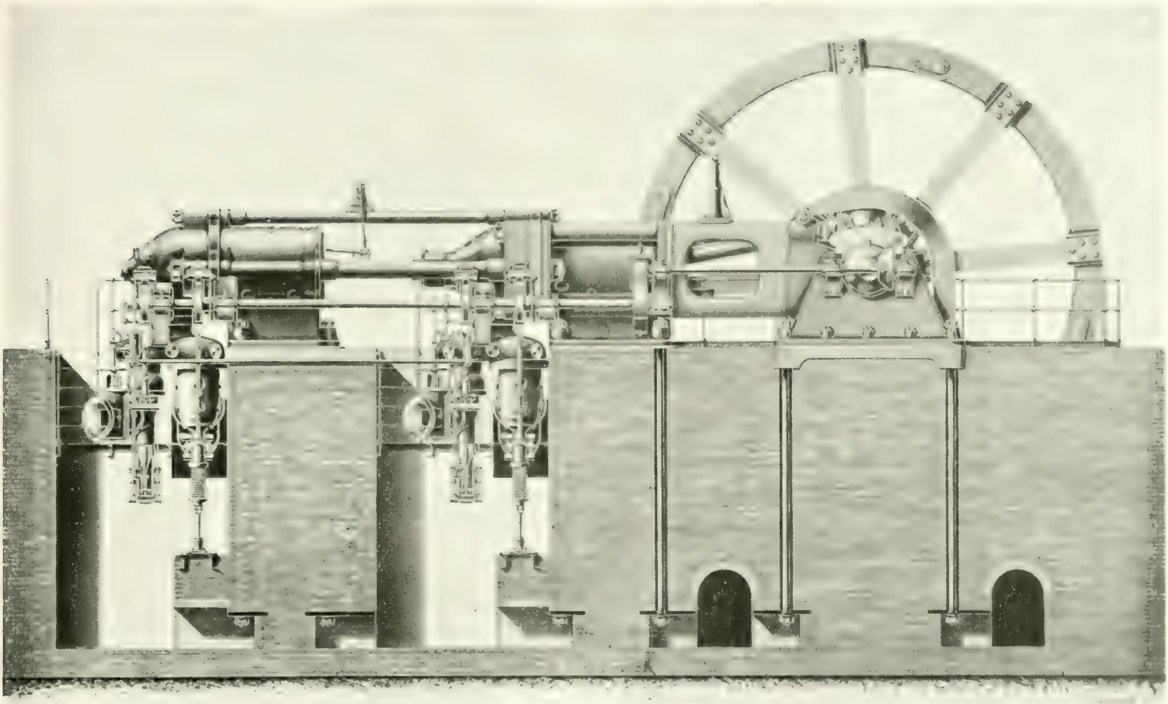


FIG. 6. FOUR-CYCLE ACTION TWO-CYLINDER TANDEM SINGLE-ACTING FURNACE-GAS ENGINE.
1,300 b.h.p. Cockerill system.

water-cooled piston of the double-acting explosion cylinder. The cam operated admission valves are supplied first with a current of air immediately after the power piston has uncovered the central exhaust ports; this is to scavenge out the hot exhaust products before the delivery of the charge of air and gas by the two charging pumps, and is effected during the period of the dead centre, and before the closing of the exhaust ports by the power piston. The charge is now compressed to about eight atmospheres before ignition; this operation is repeated at each end of the cylinder at every revolution.

Another engine working on similar lines is the Oechelhauser balanced two-cycle furnace gas engine, which type is illustrated by a 1,000 b.h.p. size engine (fig. 2). In this design there is a three-throw crank shaft connected to two power pistons working in one long cylinder open at both ends, provided with two series of port openings controlled by the two pistons; both admission and exhaust valves are thus dispensed with, the method of exhaust being identical with the Körting engine. The supply of scavenging air and charge of gas and air is forced into the explosion cylinder by the double-acting combined air and gas and air charging pump at the rear. This engine is single-acting and when arranged coupled up to an electric generator in pairs gives good results.

There are at present only these two engines made in large sizes that work on the Clerk cycle movement; there are, however, several types of engines of large size that work on the four-cycle or Otto movement. One of these is the face-to-face double-cylinder engine, as illustrated by the sectional elevation (fig. 3), of a Deutz Otto, designed to develop 500 b.h.p. on blast-furnace-gas; this type of engine requires a comparatively heavier flywheel owing to the two impulses being both delivered in one revolution, the succeeding turn of the crank receiving no impulse at all. The controlling mechanism of the two cylinders is completely

independent, and results in a rather complicated arrangement of the necessary pipes for the gas, air, exhaust, and cooling-water. This type of engine is made in large numbers in sizes up to 250 b.h.p. per cylinder.

Engines of the single-acting Otto type, with one cylinder, are made by the Sté Cockerill up to 650 b.h.p. for blast-furnace-gas; and by the Maschinenfabrik, Augsburg; and Soest and Co., Düsseldorf, up to from 300 b.h.p. to 400 b.h.p. for furnace-gas. In each of these engines water-cooled pistons with advanced crossheads working in separate guides to minimise cylinder wear are used, but they require comparatively heavy frames, crankshaft, and flywheels for the power developed.

A single-acting tandem engine of 1,300 b.h.p. is illustrated in elevation and plan by figs. 6 and 7, and a coupled pair of engines of 800 b.h.p. each by fig. 9.

The tandem single-acting Otto type, as made by the Premier Company, is illustrated by fig. 4, and shows a 500 b.h.p. engine with separate air pump for scavenging the two-power cylinders after each explosion. There is in this engine a forward impulse at each revolution at equal intervals, and on producer-gas some very economical results have been obtained; an engine of this make to develop 500 b.h.p. per cylinder is being constructed for use in this country with gas from bituminous coal.

MOST SUITABLE TYPE FOR VERY LARGE POWERS.

The largest power-gas engines are of the double-acting and tandem double-acting Otto type, as made by the Sté Cockerill, the Westinghouse Company, the Maschinenfabrik, Augsburg, and in some smaller sizes by the Sté Letombe.

Engines of this type capable of developing 2,500 b.h.p. on blast-furnace-gas are illustrated by sectional elevations (figs. 5 and 8), which show very clearly the general arrangement of water-cooled pistons and rods, and packing-boxes; the mechanically opened and closed induction and water-cooled exhaust valves; the special provision for compensating for the differential expansion of the cylinder walls. The exact method adopted by the different makers varies in degree, but all use a separate cylinder liner, separate breach valve chambers, and separate outer-cylinder frames. All have examination doors on the breach ends for clearing out periodically any deposit of cinder ash, and all have duplicate electric igniters. Nearly all use the annular system of mixing the gas and air, which is controlled by either throttling or by direct cut-off, and all use forced lubrication.

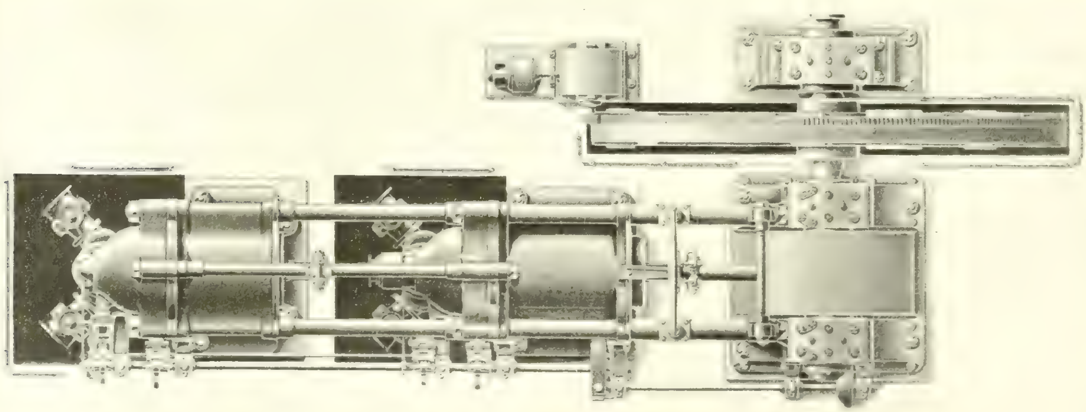


FIG. 7. FOUR-CYCLE ACTION TWO-CYLINDER TANDEM SINGLE-ACTING FURNACE-GAS ENGINE. 1,300 b.h.p. Cockerill system.

Large Power-Gas Engines.

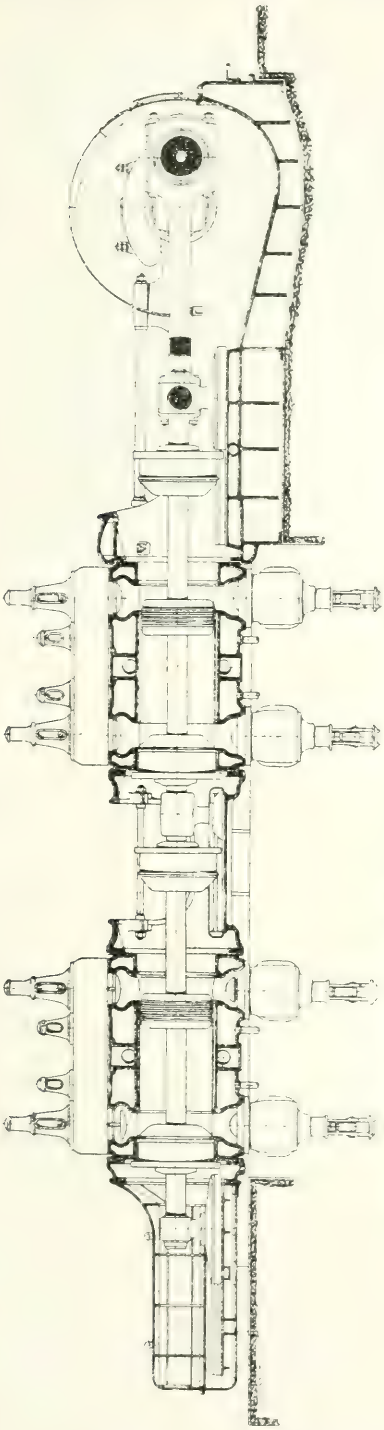


FIG. 8. TWIN FOUR-CYCLE ACTION TWO-CYLINDER TANDEM DOUBLE-ACTING FURNACE-GAS ENGINE.
2,000 b.h.p. Nürnberg system. (Showing cylinder covers removed for cleaning.
Four Cylinders: 34 in. diameter, 44 in. piston stroke.

Engines of this type are being made up to 3,000 b.h.p. for one crank, and when arranged in couples are capable of driving electric generators of twice this power.

BRITISH CONCESSIONAIRES FOR THE MANUFACTURE OF LARGE POWER-GAS ENGINES.

The British Westinghouse Electric and Manufacturing Co. Ltd.
Fraser and Chalmers, Ltd.
Mather and Platt, Ltd.
Richardson, Westgarth and Co., Ltd.

More than 200 engines are already in use of sufficient size to be capable of developing upwards of 250 b.h.p. from each cylinder on furnace-gas, and this number will in the course of the next year or two be nearly doubled.

ECONOMY DUE TO SCAVENGING.

The scavenging action is not at present used in either the Cockerill, Nürnberg, Westinghouse or Letombe engines; owing probably to the extra complication involved in using a separate flushing air-pump solely for this purpose. The ideal engine should be able to obtain this scavenging action incidentally as in the Köerting and Oechelhauser engines, and should in addition be able to expand its products of combustion down to atmospheric pressure by transference of the gases from the explosion cylinder to a separate expansion cylinder, which could also be utilised incidentally as a scavenging air-pump. The possible efficiency of an explosion engine, which is already higher than the most economical type of steam engine could, by this means, be increased some twenty-five per cent.; which is well worth the extra cost and complication of another cylinder for really large powers.

REQUIREMENTS FOR COMPOUNDING.

The two-cycle movement does not lend itself to exhausting with useful effect into an expansion cylinder for obvious reasons and to benefit by double expansion in a four-cycle engine an arrangement of two double-acting explosion cylinders can be well used in conjunction with one combined expansion and scavenging cylinder. Ordinary balanced piston valves are suitable for exhausting the low-pressure cylinder and the exhaust valves of the explosion cylinder in addition to being water-cooled, should be balanced against pressure from either side, and give large opening, so to minimise loss of power from wire drawing.

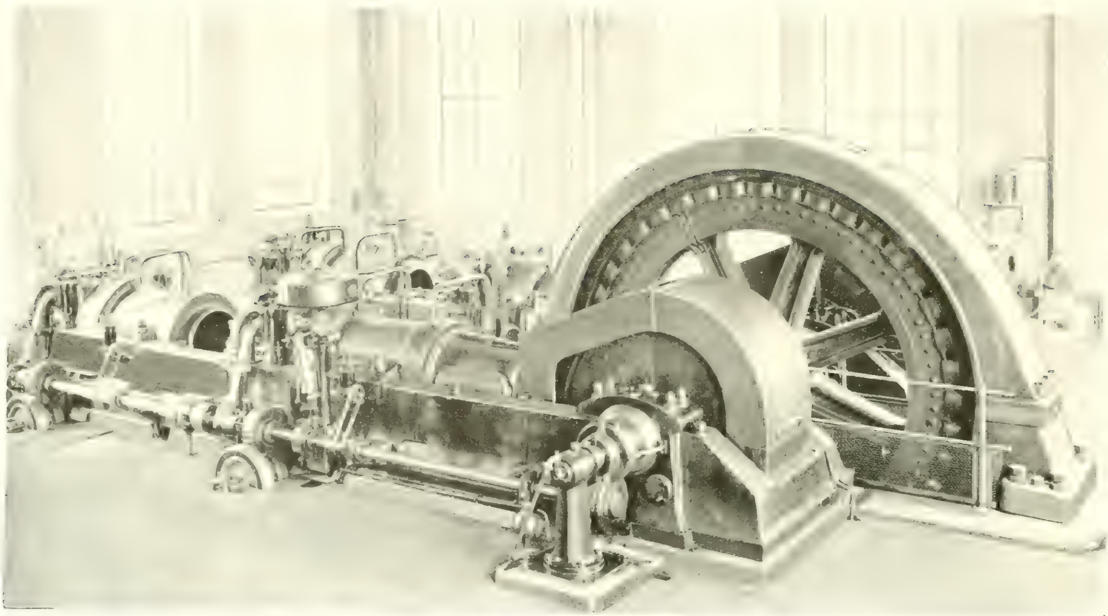


FIG. 9. THE NÜRNBERG TANDEM SINGLE-ACTING GAS ENGINE.
Twin 1,600 b.h.p. furnace-gas engines and alternator for Hutte Phœnix, Laar bei Ruhrort.

SOME POSSIBLE FUTURE IMPROVEMENTS.

As to the future development of large power engines, there seems to be no reason why the explosion engine should not be made in still larger sizes to meet any possible demand for increased power, provided always that due precaution be allowed for such contingencies as unequal expansion in the construction of the cylinder walls, the valves, valve seatings, and other working parts. It would be much in favour of the internal combustion engine if the initial temperature of the explosions could be reduced without sacrificing power, such as by supersaturation of the explosive charge by condensed water. Many experiments have been made with water spray injections in different ways on small engines, and it would be highly interesting to know exactly what possible advantage might be obtained from this source on a really large engine ; there is so great a loss by radiation that one may well hope that some feasible means will be discovered for reducing the tremendous proportion of energy carried away by the various streams of cooling water from the cylinders, pistons and valves.

POSSIBILITIES OF PRODUCER-GAS.

The principal opening at present for large power engines would seem to be in connection with the more economical utilisation of blast-furnace and coke-oven gas, which are sources of ready available energy requiring no special generators. Producers are being made now that will supply a powerful gas at a constant quality from bituminous coal and capable of continuous use without excessive deterioration. It is thus possible to profitably work engines of very large powers which are bound to find extensive use in the near future in the many large generating stations which are being provided for power, traction and lighting all over the civilised world.

ADMINISTRATION BUILDING AT THE ST. LOUIS WORLD'S FAIR.

THE ST. LOUIS WORLD'S FAIR.

BY

OUR CHICAGO CORRESPONDENT.

IN February last I was able to give some idea of the appearance of the more important buildings in course of erection at St. Louis. The accompanying illustrations, obtained during a recent visit, show the leading features of the exhibition in a more advanced stage.

One of the finest buildings of the Exposition group is the Palace of Machinery, which has a prominent place upon the western arm of the main transverse avenue of the Exposition, opposite the Palace of Transportation. The structure is 1,000 ft. long by 525 ft. upon the eastern half and 300 ft. upon the western part. The interior is arranged in five east and west aisles, each 100 ft. wide. Three of the aisles extend the entire length of the building. The remaining two are 460 ft. long.

The main entrance in the north façade presents a fully developed arcade of five bays, the massive piers of which are highly ornate. Above the three central

A GENERAL VIEW SHOWING PROGRESS OF CONSTRUCTION AT THE WORLD'S FAIR.

VIEW FROM ROOF OF THE VARIED INDUSTRIES' BUILDING, SHOWING MACHINERY PALACE AND CORNER OF THE EDUCATION BUILDING.

bays rises an attic feature, accentuated by pairs of Corinthian columns, between which are three large panels. The middle panel bears on its surface a mammoth time-piece, the east panel carrying a relief of a modern locomotive, while the west panel is relieved by a staff-designed printing press. Over the panel designs is a crowning central sculptured group, showing Justice in heroic size awarding prizes. On either side are smaller groups harmonising with the thought expressed in the central figure. The great Palace of Machinery is now practically finished.

On each side it presents entirely dissimilar design and contour. The style adopted in construction is that of the fully developed Italian Renaissance.

The north façade, which is the dominant one of the building, stretching east and west a full thousand feet, has a lofty centre pavilion flanked by two great towers, the topmost pinnacle of which reaches skyward 265 ft. Regulation railway trains may enter the building from the west through three arches, each 48 ft. wide and 55 ft. high. The aggregate width of all the entrances is 511 ft.

The steam and gas required to drive the engines in the Machinery Palace will be generated in an iron and steel annexe adjoining it on the west. In this building, which is 300 ft. wide by 370 ft. long, will also be generated the steam for the vast amount of power needed to drive the exposition machinery in all parts of the grounds.

ELECTRICITY PALACE AT THE WORLD'S FAIR.

The St. Louis World's Fair.

In the construction of the Machinery Palace there were used 1,403 tons of castings, bolts and rods, washers and nails. Two hundred tons of nails were driven. Seven million feet of lumber were used. Fifty tons of white lead were consumed in the painting of 800,000 square feet of surface, and 112 barrels of linseed oil were used in mixing it. The cost of the completed structure was $496,557.

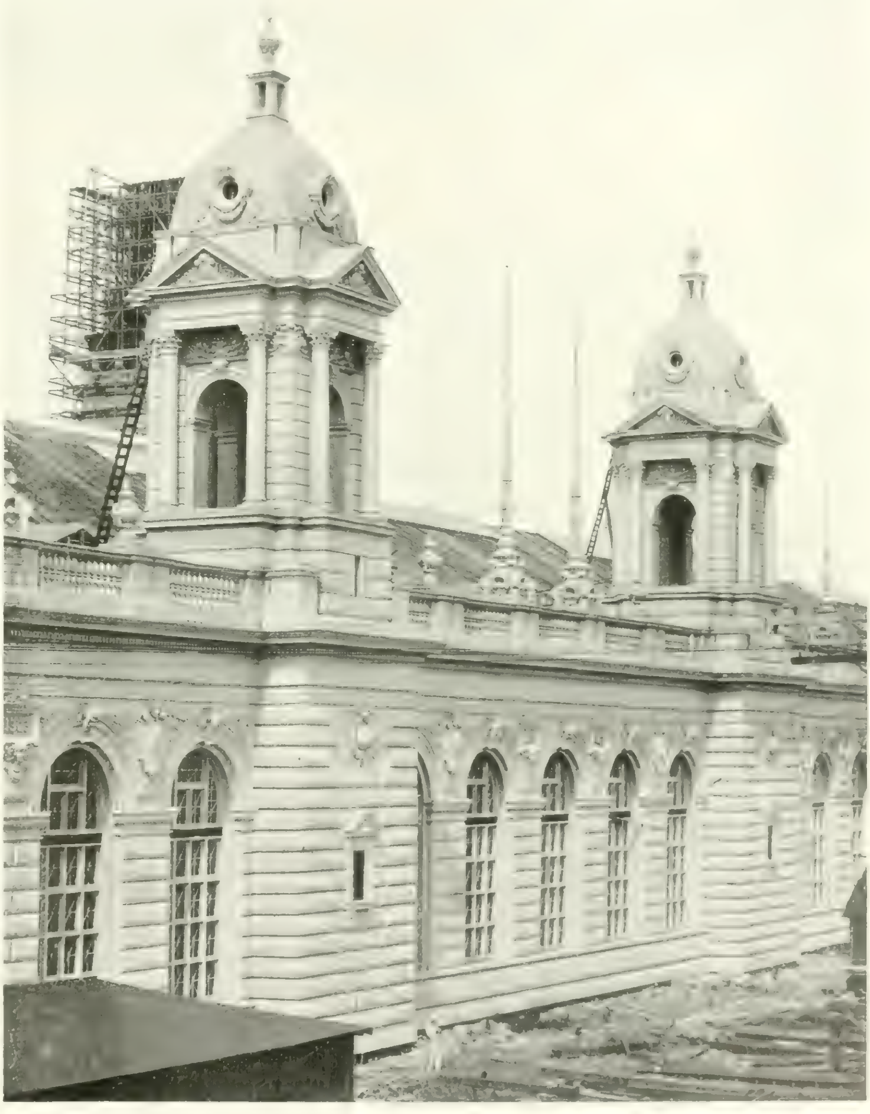
The accompanying views also show the Administration, Electricity and Education buildings, etc.

Mr. T. W. Moore, Chief of the Department of Machinery, reports that the total power generated and used by the Exposition will be in the neighbourhood of 50,000 h.p. A relatively small percentage of this will be 500-volt direct current. A still smaller proportion will be 2,400-volt, three-phase, 50-cycle alternating current, and very minor items will give 110-volt and 220-volt current, but over 80 per cent. of the electric energy available will be in 6,600-volt, three-phase, 25-current.

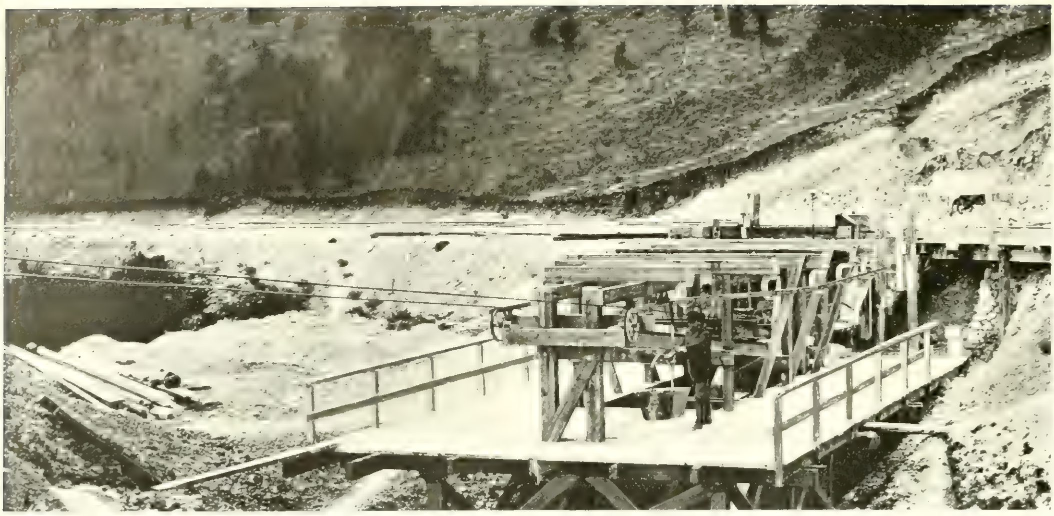
The largest unit of this great power plant will be an 8,000 h.p. steam turbine, and the next largest a 5,000 h.p. compound horizontal and vertical reciprocating steam engine — the last-named from Seraing, Belgium.

By comparison with former Expositions, the following facts appear: The largest steam engine in the Chicago Exposition was rated at 2,500 h.p., and the largest gas engine in that Exposition at 10 h.p. The largest steam engine in the Paris Exposition of 1900 (which, by the way, was the largest steam engine ever exhibited in any Exposition up to that time) was rated at 4,000 h.p. At St. Louis will be shown a steam engine of over three times the power of the largest shown in the Chicago Exposition, and over twice the power of any shown in the Paris Exposition; or, in fact, in any exposition prior to this time.

The comparison with reference to gas engines is still more impressive. The engines to be seen at Chicago were relatively mere toys, and the largest exhibited up to the present time have been those shown at the Paris Exposition of 1900, and the Düsseldorf Exposition of 1902. From this it will appear that the 3,000 h.p. engine to be set up at St. Louis exceeds by five times the power of any gas engine ever before publicly exhibited.



A PORTION OF THE WEST FAÇADE, MACHINERY BUILDING.



LOADING STATION AT THE QUARRIES.

A NEW ROPEWAY AT DORKING.

WE illustrate a new line which has been installed at Dorking by the Ropeways Syndicate, Ltd., for the purpose of conveying chalk from the quarries and dumping it into two kilns. This has taken the place of ground tracks worked by locomotives.

The line is about 700 yards long, with a capacity of fifteen tons per hour. There is a difference of twenty-two yards in favour of the load, and only about three h.p. actual is required to drive it. The ropeway runs at a speed of 130 yards per minute, and carries loads of about 4 cwt. each.

The system generally installed by the company under the Roe and Bedlington patents, comprises an endless constantly moving rope which both supports the loads and carries them along, but at the stations they come to rest on shunt rails for the purpose of loading or unloading. When, however, the proposed ropeways are of very small capacity, a constantly moving carrier system in employed.

UNLOADING STATION SERVING KILNS ON EITHER SIDE.

Our Monthly Biographies

Mr. JOHN A. F. ASPINALL, M.I.Mech.E., A.M.Inst.C.E.,

General Manager of the Lancashire and Yorkshire Railway.

Mr. John Audley Frederick Aspinall was born in Liverpool in 1851. His great-grandfather, John Bridge Aspinall, was, in 1801, mayor's bailiff and coroner of Liverpool, and in 1803 held the mayoralty of that city. Thirty-one years later the mayoral chair was again filled by a member of the Aspinall family, James Aspinall—a great-uncle of the subject of this sketch.

Mr. Aspinall received his early training at Beaumont College, in Berkshire, where he showed a marked aptitude for mechanical pursuits. With a wise recognition of the bent of mind strongly evidenced in his boyhood, he was, at the close of his collegiate career, articled as a pupil at the Crewe Works of the London and North-Western Railway Company to the late Mr. John Ramsbottom, which pupilage he completed under Mr. Webb, who has just retired from the position of mechanical engineer to that company.

At the end of that time he was appointed assistant works manager in the steel-making department, with charge also of the erection of all new buildings connected with the Locomotive Department of the London and North-Western Railway.

Photo. by N. S. Kay, Bolton.]

MR. JOHN A. F. ASPINALL, M.I.MECH.E., A.M.INST.C.E.

When the late Mr. J. C. Park left Ireland to become the locomotive, carriage, and wagon superintendent of the North London Railway, Mr. Aspinall succeeded him, in 1875, as works manager of the Great Southern and Western Railway Company's Works at Inchicore, Dublin; and in 1883, on Mr. Alexander McDonnell vacating the post of locomotive, carriage, and wagon superintendent of that company for a similar position on the North-Eastern Railway, Mr. Aspinall succeeded to the office.

Returning to England in 1886 to assume the duties of chief mechanical engineer to the Lancashire and Yorkshire Railway Company, Mr. Aspinall found a work of considerable magnitude before him. The Company's Locomotive Works at Miles Platting and Bury were altogether antiquated and inadequate even for dealing with repairs. The building of the new works

at Horwich had just been commenced, and the erection of the buildings, the arrangement of the [illegible], and the general equipment of the various workshops were among the duties which confronted him. How he succeeded in his task of organisation and supervision is known to those who have visited the Horwich Works. Admirably arranged and well lighted, they are by many considered to be the finest works of their kind in the country.

Whilst in Dublin, Mr. Aspinall became a member of the Institution of Civil Engineers in Ireland. He was successively a member of the Council, Vice-President, and finally President of the Institution for the two sessions [illegible] 1880, during which time he contributed several papers to the proceedings. In 1881 he became a member of the Institution of Mechanical Engineers, and an associate member of the Institution of Civil Engineers, of which latter body he was elected a member in 1887, and received a Telford premium in 1888. In 1885 he was appointed a Vice-President of the Inventions Exhibition held in London in that year; in 1887 he was elected a member of the Iron and Steel Institute. In [illegible] he was made a member of the Council of Mechanical Engineers, and is now Vice-President of that Institution. In 1898 he occupied the chair of President of the Institution of Junior Engineers, and two years ago was President of the Liverpool Engineering Society.

In [illegible] Mr. Aspinall contributed an exhaustive paper on "Express Locomotives" to the proceedings of the International Railway Congress, and he has repeatedly enriched the proceedings of the Institution of Civil Engineers as well as of the Mechanical Engineers. A short time ago he read an interesting paper on "Train Resistance" before the Institution of Civil Engineers. It may be recalled that this paper dealt with the results of experiments carried out with a dynamometer car on the Lancashire and Yorkshire Railway in an endeavour to arrive at the tractive effort required to haul modern railway carriages. The author stated that a long series of experiments, the results of which were not recorded in the paper, had been previously tried, but that the effect of the wind upon trains was such as to require a much closer investigation into this special branch of the subject. The records then presented were the results of a careful set of experiments made with a view to show how much more important the question of wind pressure was, as affecting trains, than any other item in the total resistance. This paper [illegible] all railway engineers. It will be found in the records of the Institution of Civil Engineers [illegible] an appendix giving in tabular and graphic form the results obtained by a number of previous investigators, with references. For this paper he was awarded a "Watt" Gold Medal by the Institution of Civil Engineers

In July, 1899, Mr. Aspinall was appointed by the Directors of the Lancashire and Yorkshire Railway as general manager of that important company, in succession to Mr. J. H. Stafford, and it is interesting to note that this is the first instance that can be recalled in English railway history of a mechanical engineer having been chosen as general manager of such an undertaking. During the four years he has been chief officer of that company he has pursued a vigorous policy, being determined that the Lancashire and Yorkshire Railway should rank among the very first in the United Kingdom in the excellence of the services provided for the travelling public.

The success which has attended the introduction of Mr. Aspinall's locomotives on this railway is well known, and it is a fact that at the present time some of the fastest passenger and heaviest goods and mineral trains are to be found running over the Lancashire and Yorkshire system. It is also interesting to note that the Lancashire and Yorkshire Company will probably be the first ordinary railway company in the United Kingdom to work trains by electrical traction, as, in the autumn of last year, the directors of that company decided to electrify a portion of their railway between Liverpool and Southport (18½ miles), and it is expected that the work will be complete before the end of the present year.

In 1900 Mr. Aspinall was asked to contribute a paper to the International Railway Congress on the subject of "The Purification of the Feed Water of Locomotives, and the Use of Disincrustants," and since its publication he has been the recipient of congratulatory communications from engineers and others who are interested in this subject, in practically all parts of the globe.

This brief sketch would not be complete without some reference to the Horwich Institute and Technical School, which was provided largely through the instrumentality of Mr. Aspinall. The success which has attended his efforts in this direction has been most gratifying to everyone concerned, including the directors of the company, who take a deep interest in the Institution, and also to Mrs. Samuel Fielden (the widow of a late director), who erected at her own cost two wings to the main building, and endowed a gymnasium as a further adjunct to the equipment of the Institute.

The mechanical and chemical laboratories forming one of the wings which Mrs. Fielden provided, are fully equipped, and the mechanical laboratory, in particular, is largely unique in its character, by reason of the extent of the appliances which are used in connection with the classes which are held in the Institute.

THE HONORARY LOCAL SECRETARIES AT THE LEEDS MEETING OF THE INSTITUTION OF MECHANICAL ENGINEERS.

Photo. by J. Rosemont.] *Leeds.*

MR. E. KITSON CLARK, M.A., M.I.MECH.E.

Mr. CHRISTOPHER JAMES, M.I.Mech.E.

Mr. Christopher James may be said to have followed a hereditary occupation, being the son of Christopher James, consulting engineer of Bristol, while his great-grandfather, grandfather, and uncle were successively engineers to the Cyfarthfa Works, in South Wales. Curiously enough, his grandfather was the first to make a vertical testing machine with hydraulic pulling cylinder and lever weighing mechanism, while he himself has long been engaged under Mr. J. Hartley Wicksteed in the development of the modern testing machine, the germ of which existed in 1829 at Cyfarthfa.

After the usual Public School education and a period of two years on the Continent, chiefly in Germany and Switzerland, he began his engineering career in the shop of Sharp, Stewart and Co., then of Manchester. After a short time there, and a year as assistant to his father, he entered on a regular apprenticeship with Oliver and Co., Ltd., of Chesterfield (now Markham and Co., Ltd.). During this period he attended the engineering course at the Sheffield Technical School, under Professor Ripper, and later studied under Professor Barr at the Yorkshire College, Leeds.

About seventeen years ago, he entered the service of Joshua Buckton and Co., Ltd., Leeds, of which firm he is now one of the joint managing directors. He is devoted to the development of new and special machine tools, and is an advocate of high speeds and powerful machines.

Mr. EDWIN KITSON CLARK, M.A., M.I.Mech.E.

Mr. Edwin Kitson Clark is a Yorkshireman on both sides, his father having been for many years Regius Professor of Civil Law at Cambridge. He was educated at Sutton Valence, Shrewsbury (head boy), and Trinity College, Cambridge (scholar), taking first-class honours in the classical tripos. On leaving Cambridge he at once commenced practical training for the engineering profession, passing through the works of Messrs. Kitson and Co., Leeds, where he had the special advantage of pursuing his studies under his uncle, the late Mr. Hawthorn Kitson, and Mr. T. P. Reay. The whole of Mr. Clark's engineering career has been associated with the same firm, of which his uncle, Sir James Kitson, is now chairman. Having been successively assistant works manager and works manager, he was in 1897 taken into the firm as a partner, and he is now a director of the firm of Messrs. Kitson and Co., Ltd. Mr. Clark is a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. He is keenly interested in archæology and is a Fellow of the Society of Antiquaries. He also acts as Secretary of the Leeds Philosophical and Literary Society.

Mr. Kitson Clark married in 1897, Ina, third daughter of Mr. George Parker Bidder, Q.C., and has two sons.

Photo. by J. Rosemont.] *Leeds.*

MR. CHRISTOPHER JAMES, M.I.MECH.E.

Photo. by J. Rosemont.

MEETING OF THE INSTITUTION OF MECHANICAL ENGINEERS AT LEEDS.

The Institution of Mechanical Engineers.

A PICTORIAL AND STATISTICAL VIEW OF ITS MEMBERS.

NOT the least interesting function connected with the summer meeting of the Institution of Mechanical Engineers was the assembly of members on the steps of the Town Hall at Leeds for the purpose of being photographed.

An account of the Leeds meeting will be found at page 240. The smooth working of the programme throughout reflected considerable credit upon the whole of the officials, honorary and otherwise, the amount of organisation required for a conference of more than 500 members being by no means a light matter; in fact Mr. Edgar Worthington, the Secretary, must have had his hands full for some time past. The honorary local secretarial duties were efficiently undertaken by Messrs. E. Kitson Clark, M.A., M.I.Mech.E., and Mr. Christopher W. James, M.I.Mech.E.

The total number of all classes on the roll of the Institution at the end of 1902 was 3,802, as compared with 3,400 at the end of the previous year, showing a net gain of 402, compared with corresponding gains of 238, 243, and 325 respectively during the years which have elapsed since the Institution took possession of its new House. During last year 565 candidates were elected, of

THE MEMBERS PHOTOGRAPHED ON THE STEPS OF THE TOWN HALL.

whom 43 were former Graduates elected as Associate Members; and four elections became void, thus making 518 names added to the register.

A rapid increase of membership has been in progress for several years. It was attributed at the last annual meeting, by Mr. Maw, to the work which was done at the time when it was resolved to make the Institution a London Institution, and secondly to the determination of its members to build a home of their own, thus taking the position to which they were entitled among the important societies of London.

The province of the Institution was forcefully stated by the President, Mr. J. Hartley Wicksteed, in his recent address to the members. "We are associated," he said, "as members of this Institution, for the purpose of promoting 'The Science and Practice of Mechanical Engineering.' The history of Mechanical Engineering is co-existent with the history of Iron. As the production of Iron has developed, so have the works of the Mechanical Engineer. His monuments are in iron; with it he builds ships, guns, engines, and all sorts of machines by which the labour of man is lightened and is increased in its productiveness, and the circulation of mankind through the arteries of the world is increased in volume and rapidity. A current of humanity is created through all the nations, and this is the very contrast to congestion and stagnation. It carries ideas and [illegible] specialities of distant climes and races. It stimulates production in all industries, and what industry is there to which the Mechanical Engineer has not lent his assistance?"

THE STEWART-EATON CINDER POT.

An improved cinder car has been recently patented in America which can be tilted by steam or compressed air, and it is claimed that it not only provides for easy dumping, but can also be readily cleansed of the scale with which the bottom becomes coated after continued use.

The dumping and cushioning cylinders are cast together, and there is a rack moving in a guide cast on one of the cylinders. The rack has an arm to which the piston rods are secured, and, on the raising or lowering of the rack, a gear wheel keyed on the trunnion of the pot is rotated to a corresponding extent, the limit to which the pot is usually tipped being 90 deg. The air or steam is admitted or exhausted from the cylinder by a 4-way valve. When several of these cars are used, forming a train, the main steam or air-pipes are connected together, so that a supply of steam from the boiler of the engine or other source may be applied to the entire train.

The cleansing is effected by means of a plate which is placed on the bottom of the pot, and is provided with a stem connected to a lever operated by the piston of a steam or compressed air cylinder.

When a crust has formed over the bottom of the cinder pot, and it is necessary to break this up, steam or air is admitted into the upper end of the cylinder. This forces the piston of the cylinder down, by means of the connecting levers, pushes upward the steam passing through the bottom of the pot, raising the plate inside and thus breaking the crust formed over it. Then by turning the handle of the valve 90 deg. in the opposite direction, the upper end of the cylinder is opened to the exhaust, while steam or air is admitted to the other end, bringing the plate back to its normal position in the bottom of the pot.

The Stewart-Eaton cinder car is manufactured by Messrs. Hickman, Williams and Co., of Cincinnati, and to Mr. Frank M. Eaton of that city we are indebted for the photos, which were taken at Roanoke, Va., where two of these pots have been in use for the past ten or twelve months (see Frontispiece). It is claimed for them that they effect a saving in labour and repairs. With the old style pot it was necessary to have a man whose exclusive duty was dumping and cleaning, while with the new improvement the switchman on the locomotive can attend to this work, in addition to his usual duties, as it is only necessary for him to open a valve to dump the pot, and open a second valve to clean it With the old style pot it was necessary to cool the skull with water before it could be dug out. This constant drenching causd the iron work to expand and contract a number of times a day, and the life of the lining was thus very limited. With the Stewart-Eaton cinder pot it is unnecessary, at any time, to use water.

Our frontispiece shows the cinder pot in actual operation, and the accompanying illustration will serve to give a clearer notion of its arrangement.

SIDE VIEW OF THE STEWART-EATON CINDER POT

THE NEW 16-IN. UNITED STATES COAST DEFENCE GUN.

BY

HERBERT C. FYFE.

The recent successful trials of the new United States Army 16-in. breech-loading gun at the Sandy Hook Proving Ground have drawn attention to this weapon as one of the most powerful pieces of ordnance in existence. That it is destined to play an important part in coast defence is improbable; but apart from its potential military value the gun is a splendid piece of mechanism, reflecting great credit on the authorities responsible for its design and construction, and is of sufficient interest to merit a more detailed description than we have hitherto been able to give it.—ED.

THE new 16-in. breech-loading gun is the first of a series of similar gigantic weapons which were proposed for the sea-coast defence of the United States. The Endicott Board, which had the whole subject of sea-coast defence under consideration some years ago, reached the conclusion that eighteen of these weapons should be provided for the protection of New York. The Board also recommended that ten 16-in. guns should be mounted at San Francisco, eight at Boston, and four at Hampton Roads.

DESCRIPTION OF GUN.

The total length of the gun is 590·9 in. (49 ft. 2·9 in.), with a diameter of the rear portion of 60 in., the forward part gradually diminishing from 60 in. to 28 in. at the muzzle.

The length of main bore is 448·5 in. (37 ft. 4·5 in.), with a diameter of 16 in.; the cylindrical part of the powder chamber is 90·7 in. long, with a diameter of 18·9 in.; this is connected with the main bore by a conical slope 24 in. long. The volume of the powder chamber is 29,385 cubic inches. The main bore is rifled, having ninety-six lands and ninety-six grooves; the depth of each groove is 0·06 of an inch; the rifling curve is of increasing twist, being a semi-cubic parabola, starting with one turn in 50 calibres, gradually increasing to one turn in 25 calibres at the muzzle.

The breech recess, containing the threaded and slotted portion for the locking of the breechlock, is 24·4 in. long, with a diameter of top of threads of 24·86 in.

The gun is built up of the following parts:—

A tube, 566·5 in. long, with a maximum outside diameter of 29·3 in.; two C hoops, which are shrunk over the tube from the forward end of the jacket to the muzzle.

The jacket is 304·65 in. long, and is shrunk on the rear portion of the tube from the end of the C hoop; the rear end of the jacket, for a length of 24·4 in., overhangs the tube and forms the breech recess.

The D hoop, which is 144·5 in. long, is shrunk over the forward end of the jacket, and rear part of the C hoop; its bore contains two locking shoulders, which grip over two corresponding shoulders on the jacket and C hoop, thus interlocking the whole system, and preventing any sliding backward of the jacket or sliding forward of the C hoops, due to the shock of firing.

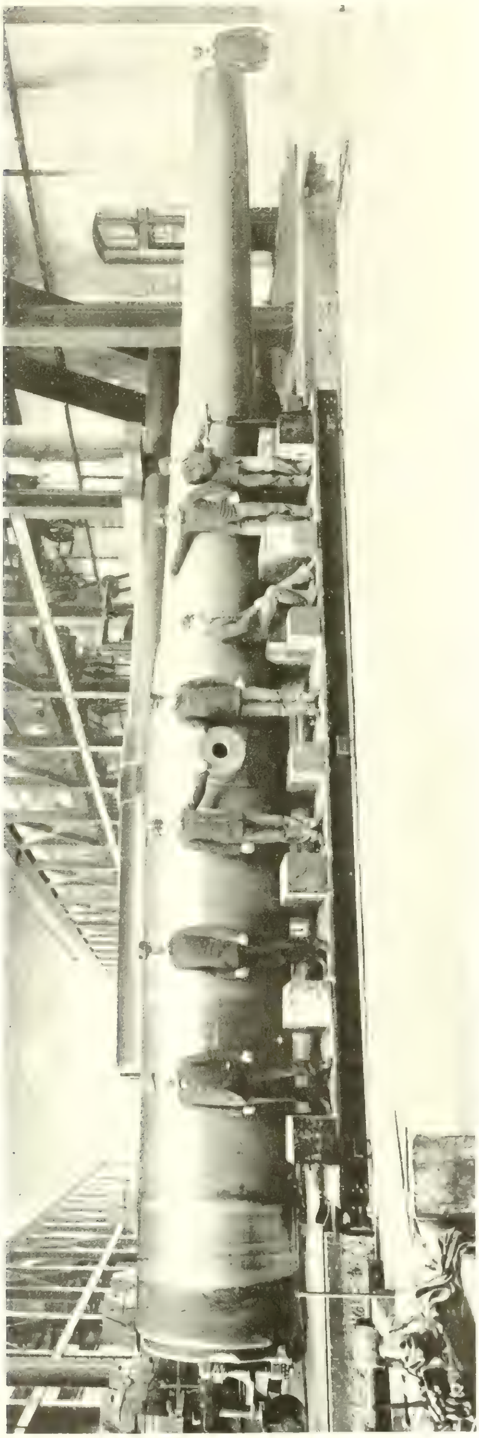
Three A hoops are next shrunk on; the A1 hoop overlaps the rear part of the D hoop with its front end, and the outer service of the jacket with its rear end; the hoops A2 and A3 are shrunk directly over the outer surface of the jacket.

The B hoops are shrunk outside of the A hoops.

BREECH MECHANISM.

The breech mechanism for this gun is denominated the "Stockett system," a modification and simplification of the Farcot-Fletcher system, and consists of the following principal parts: Breechblock, consol or tray with latch, hinge plate, obturator spindle with appurtenances, compound gear, worm wheel, and worm with worm shaft, rotating crank and handle.

The breechblock has a diameter of 26 in., and a total length of 27·3 in., with a length over the threaded portion of 1[illegible] in. The threaded portion is divided into twelve sectors, six threaded and six blank, each sector being 30 deg., corresponding to similar sectors in the breech recess of the gun. The pitch of the thread is 1·71 in.; on the rear end of the breechblock is a projection where the rotating rack is cut; the teeth of this rack have a normal pitch of 1·50 in., and a circular pitch of 1·577 in.; the longitudinal thread pitch of these teeth is one turn in 248·25 in.



GENERAL VIEW OF THE NEW 16-IN. COAST DEFENCE GUN.
Showing relative size of gun and men.

The block is bored out and recessed for spindle, nuts, etc. The translating rack is cut on the right-hand side of the block; the pitch of the teeth of this rack is 2·426 in.; the depth of the teeth is 1·11 in.

Both the rotating and the translating racks are cut out of the solid block.

The consol or tray is a steel casing. The guide rails are flat, and have a length of 16 in. The distance from centre of tray to centre of hinge lug is 15·70 in., and the height of hinge lug 15·55 in.

The tray latch is pivoted underneath the tray, and is arranged so as to open and close automatically.

The hinge plate is fitted into and bolted to a recess in the breech end on the right side of the gun, and has two heavy lugs for the hinge pin; these lugs are located far enough apart to admit the hinge lug of the tray, and also the compound gear; underneath the bottom lug is a recess containing the worm and worm shaft.

The obturator spindle has a total length of 26·95 in. The mushroom head has a diameter of 18·85 in., and a thickness of 4 in. The forward part of the spindle has a diameter of 6·22 in., and the rear part 5·97 in. The end of the spindle is threaded with a left-hand thread for the obturator nut, and a right-hand thread for the locking nut; the spindle is drilled with a 0·2 in. vent hole, and the end threaded and bored for regular obturating primers; the dimensions of the rear end, however, are so large as to permit of any change it might be necessary to make when a firing mechanism for sea-coast guns has been finally determined upon.

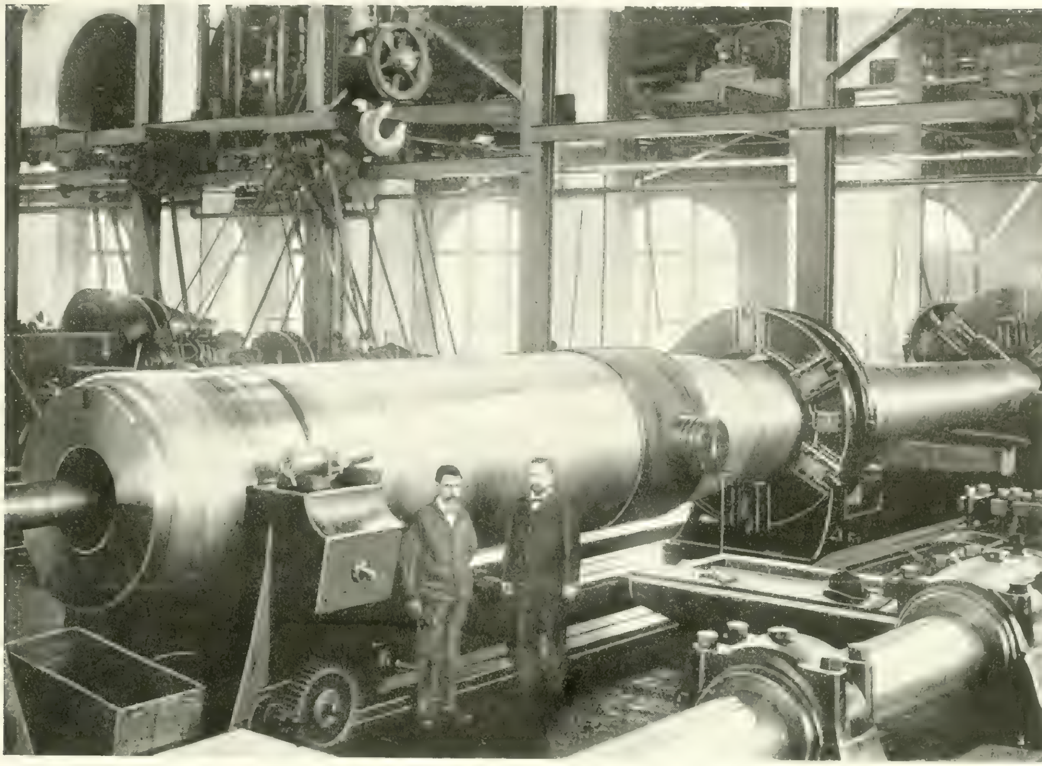
The gas-check pad, front, rear and small split rings, are the same style as those used for all other sea-coast guns at present.

The compound gear, so-called because the teeth are so arranged as to perform both the rotation and translation of the breechblock, has an outside diameter of 8·685 in., and a thickness of 3·8 in.; the spiral teeth (for rotation of block) have the same normal pitch (1·50 in.) as the rotating rack on end of breechblock, but with a circular pitch of 4·854 in., and a thread pitch of one turn in 7·885 in.; the angle of this pitch is 18 deg.

The translating teeth are formed by slotting the spiral teeth vertically; the number of these teeth is ten, with a circular pitch of 2·426 in. The compound gear is bored to a diameter of 3 in. and slotted with two keyways which bore and keyways fit corresponding parts on the hinge pin

The worm wheel is made of hard bronze and has a maximum outside diameter of 10.165 in., and a thickness of 2 in.

The New 16-in. United States Coast Defence Gun.



THE 16-IN. GUN IN PROCESS OF CONSTRUCTION.

The worm (made of steel) and the bronze worm wheel are cut according to the Hindley system, giving the maximum amount of bearing surface ; the number of teeth on worm wheel is 24 with a pitch diameter of 9·071 in., with their circular pitch cut to fit a double threaded left-hand worm, having a pitch of 2·375 in., giving a ratio of 12 to 1.

The worm shaft, is an extension of the worm, and is in one piece with the same. On the end of this is the rotating crank, which is 15 in. from centre to centre with a handle 16 in. long

The worm, with shaft is placed in the recess provided for it in the hinge plate, and has hardened steel ball bearings at each end of this recess, to take up the thrust due to rotation and reduce the friction to a minimum.

OPERATION OF THE BREECH MECHANISM.

This mechanism is so designed as to be opened or closed with one continuous motion of the rotating crank ; twenty-two and a half revolutions in one direction open the mechanism, and the same number of revolutions in the opposite direction will close it.

In manipulating the crank, the worm transmits the motion to the worm wheel and the compound gear, both of which are fastened to the hinge pin, the spiral teeth of the compound gear being engaged in the teeth of the rotating rack, rotates the breechblock. The rotation of the breechblock is limited to the proper amount by a projection on the lower end of the rotating rack striking against the underside of the compound gear, and the translating teeth of this gear are now brought into action with the teeth of the translating rack of the breechblock, with drawing this out on the consol or tray, the block being guided and supported by the guide rails of the tray engaging into the guide grooves of the block ; the amount of translation is limited by the ends of the guide grooves abutting against the forward end of the guide rails. At this point the tray latch, which has been engaged with its forward end in the tray latch catch holding the tray firmly up against the end of the gun, is being tripped by the rear end of the block, thus releasing the tray from the gun, and by the continued motion of the rotating crank, the combined breechblock and tray are swung around the hinge pin over an arc of 123, leaving the breech of the gun fully open for loading. In closing the mechanism by rotating the crank in the opposite direction, the different motions of the block will take place in the reverse order of those described for the opening of the mechanism.

Comparisons will naturally be interesting between the new American weapon and other huge guns.

The following table has been drawn up by Major J. M. Ingalls, United States Army :—

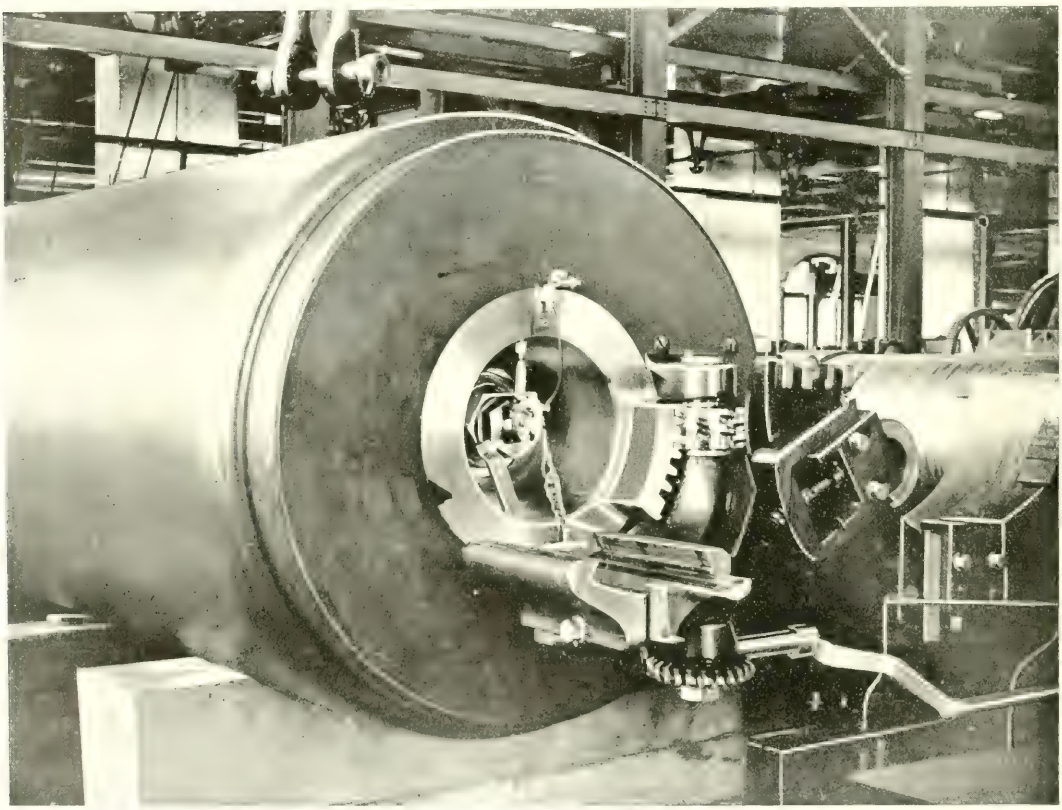
Type of Gun.	Bore in inches.	Total length in feet.	Weight in tons.	Weight of projectile in pounds.	Weight of powder in pounds.	Kind of powder.	Muzzle velocity in feet per second.	Muzzle energy in foot-tons.	Muzzle energy in foot-tons per ton weight of gun.
Armstrong ...	16·25	43·5	110·5	1,800	960	Slow burning cocoa	2,087	54,390	492
U.S. Army ...	16	49·7	130	2,400	640	Nitro-cellulose smokeless	2,300	88,000	677
Krupp ...	12	50	57·0	*771·6	344	Nitro-cellulose smokeless	*3,330	59,280	1,020

* In this comparison it must be remembered that the velocity falls off much more rapidly in the lighter shell; so that the "remaining velocities" will be proportionately greater in the 2,400-lb. projectile than in the case of the other two.

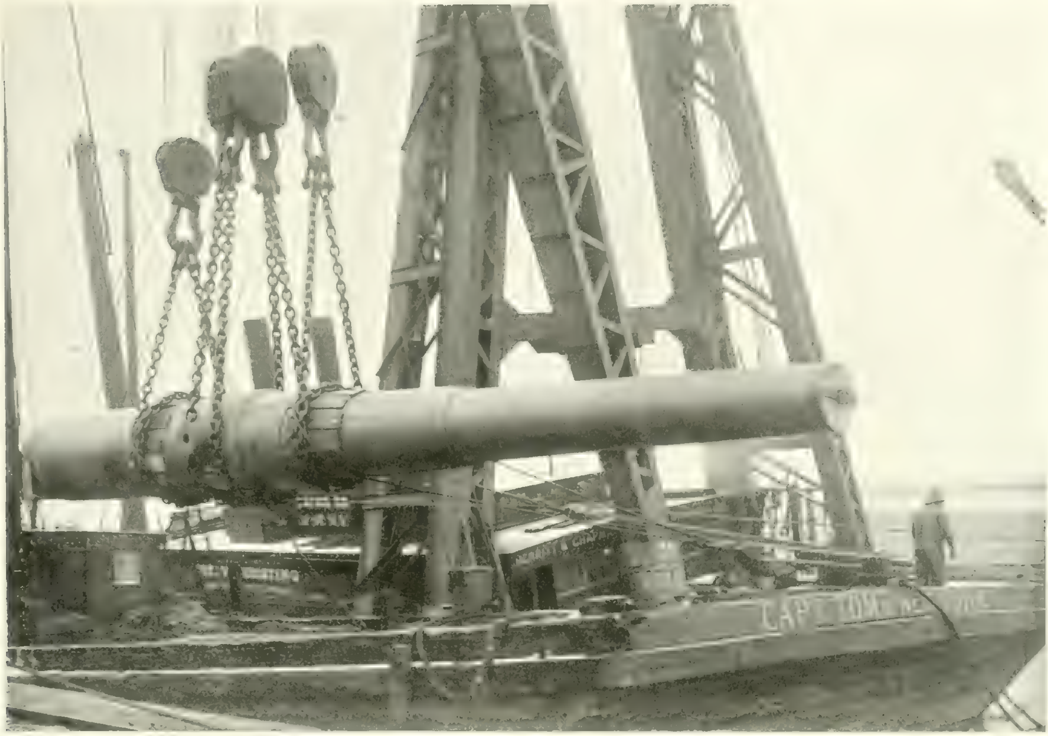
The heaviest guns at present in use in the United States Army weigh about 64 tons. The United States Ordnance Board is contemplating a muzzle velocity of 3,600 ft. per second in the new 12-in. guns.

Other rifled guns of large calibre heretofore constructed are the Italian gun, calibre of 17·75 in., the French gun of 16·5-in. calibre, and the Armstrong gun of 16·25-in. calibre, which is carried on the battleships *Benbow* and *Sans Pareil*. Not one of these compares, in point of energy and range, with the 16-in. United States gun.

The range and energy of this latter gun will, of course, vary with the quality and amount of powder used, and the question of the actual performance of the gun can therefore only be determined by actual trial tests. With smokeless powder as at present



VIEW OF BREECH MECHANISM.



TRANSPORTING THE GUN TO SANDY HOOK.

proposed, the gun requires a powder charge of 576 lb. but if the old black powder is used 1,176 lb. will be required. With a maximum powder pressure of between 37,000 lb. and 38,000 lb. to the square inch, it is estimated that the gun will throw a projectile weighing 2,370 lb. with a muzzle velocity of 2,300 ft. per second, developing a muzzle energy of 88,000 foot-tons; but it is not improbable that by using a slower-burning powder, giving a less maximum pressure (these being the qualities constantly sought for in the manufacture of smokeless powders) the gun would develop even greater velocity and energy than this, with a relatively small increase in the chamber pressure. Even on the basis given above, however, this gun shows an enormous superiority to any of the large guns above mentioned. The Italian gun, for instance, throws a projectile weighing 2,000 lb. with a muzzle velocity of 1,700 ft. per second and an energy of only 40,000 foot-tons, an energy considerably less than one half that of the new army gun; the French gun projectile, weighing 1,700 lb. with a muzzle velocity of 1,700 ft. per second, developed a maximum energy of 36,000 foot-tons; while the English gun projectile, weighing 1,800 lb., with a muzzle velocity of 2,100 ft. per second, showed a total energy of 51,000 foot-tons. The maximum energy of the Italian gun was thus 45 per cent., the French gun 41 per cent., and the English gun 65 per cent. that of the Watervliet Arsenal gun. The projectile of the gun will be 5 ft. 4 in. in length, and the penetration in steel at the muzzle corresponding to the energy given above is (De Marre's formula normal impact) 42·3 in.

Undoubtedly, the most spectacular feature in connection with this gun is its enormous range, which is estimated at about 21 miles, or, to be exact, 20·978 miles. This theoretical range has been calculated by Major James M. Ingalls, 5th United States Artillery, for many years instructor at the Artillery School for officers at Fort Monroe, Va. A firing table for this gun prepared by Major Ingalls, shows that the above range is obtainable with a muzzle velocity of 2,300 ft. per second, with the necessary angle of elevation of the piece. The trajectory of the projectile shows that in ranging to 20·978 miles the shell would reach the maximum elevation of 30,516 ft. This is enormously greater than the maximum range hitherto obtained by any other gun.

THE SUMMER MEETING OF THE INSTITUTION OF MECHANICAL ENGINEERS AT LEEDS.

AN appropriate venue for the summer meeting of the Institution of Mechanical Engineers was found this year at Leeds, the President, Mr. J. Hartley Wicksteed, being a well-known resident of that city, while no less than three of the papers read were contributed by Leeds men. The meetings were held in the lecture hall of the Philosophical and Literary Society at Park Row, and were well attended.

At the reception of the President, Council and Members of the Institution by the Right Hon. the Lord Mayor of Leeds (Mr. John Ward, J.P.) and by the Reception Committee, Mr. Wicksteed was accompanied on the platform by Sir James Kitson, Bart., M.P. (Chairman of the Reception Committee); Sir Edward H. Carbutt, London; Mr. Wm. H. Maw, London; and Mr. E. Windsor Richards, Caerleon, past presidents of the Institution; Mr. J. A. F. Aspinall, Manchester; Mr. Arthur Keen, Birmingham; Mr. E. P. Martin, Dowlais; and Mr. A. Tannett-Walker, Leeds, vice-presidents; Mr. Michael Longridge, Manchester; Mr. J. F. Robinson, Glasgow; Mr. Mark H. Robinson, Rugby; Mr. J. W. Spencer, Newcastle-on-Tyne; and Mr. H. W. West, Liverpool, members of the Council.

OFFICIAL WELCOME.

The Lord Mayor, welcoming the Institution to Leeds, recognised that theirs was an important body, comprising nearly 4,000 members, many of whom were widely scattered about the world. They had, too, a long list of illustrious past-presidents, and he noticed that the first president bore the honoured name of George Stephenson. He remarked that Leeds had been built upon the principle of utility rather than grandeur, but specially mentioned as worthy of notice their electric lighting installation and the electric tramways.

ENGINEERING REMINISCENCES OF LEEDS.

The President, in the course of a short speech, thanked the Lord Mayor for his cordial welcome. After a passing reference to the flourishing condition of the Engineering Department of the Yorkshire College, the opening of which was celebrated by a special autumn meeting of the Institution in 1886, he reminded them that in Leeds, in 1812, the first locomotive that was put on rails and made to draw a mineral train, was put down to carry coal from the Middleton Colliery to Hunslet. This locomotive was built by that eccentric engineer of great genius, Matthew Murray, who built his works in Leeds after the model of a cyclopean steam cylinder. The doors were like the parts of a steam cylinder, the floor was like the piston, and the pillar supporting the roof was like a piston-rod, while the workmen went in and out like pieces of steam. As his work increased, Messrs. Bolton and Watt became so jealous that they bought up all the surrounding land to prevent him extending his premises. The rails for that train were made in Leeds, and were three feet long. Since then rails had grown from 3 ft. to 30 ft., and then to 60 ft., while now, it was to the honour of Leeds, that they had commenced to put down rails of an indefinite length. If they had a road six miles long, the rails would be made six miles long; and it was interesting to notice that this was the first introduction into England of the continuous welding of the rails.

The President also alluded to another interesting engineering reminiscence connected with the city, and remarked that it was Mr. Blenkinsop who first tried to apply a brake to a road locomotive to prevent it running away. Unfortunately, the locomotive never started, so the brake was not tested ; but it was an interesting coincidence that one of the papers to be read at this meeting was on the subject of a brake for a road locomotive. This time it was to prevent the locomotive from running backwards. It was often said that there were no mysteries in mechanics ; but it was very remarkable that after over one hundred years this subject of a brake should still be engaging the attention of engineers.

NEW MEMBERS.

The Lord Mayor having withdrawn, the business of the Conference commenced with the reading of the names of 134 new members, by the Secretary (Mr. Edgar Worthington).

THE DIESEL ENGINE.

The first paper was read by Mr. H. Ade Clark, of Yorkshire College, on the Diesel Engine. The principles underlying the action of the engine were first stated, together with a general description of its parts.

Until April, 1902, all published trials of Diesel engines were either of Continental or American origin. So the author, upon learning that the Harrogate Corporation were putting in a Diesel engine, at once applied to the Borough Engineer, to be allowed to test it ; this permission was most courteously granted, and the author, assisted by Mr. R. Dudley, proceeded on April 9th, 1902, to test the engine on the brake. The oil used was a crude petroleum from Texas, having a specific gravity of 0·922 and a calorific value of 19,150 B.Th.U. per lb. The result of the test, less than half a pound of this oil per b.h.p. hour, was very gratifying to the author, after usually getting nearly twice this consumption from the ordinary type of oil engine. Various other tests were also described, the final result being as follows :—

Total cost per b.h.p. hour.

Engines.	Diesel.	Gas.	Steam.
	Penny.	Penny.	Penny.
35 B.H.P.	0·59	0·69	0·80
80 B.H.P.	0·39	0·52	0·63
160 B.H.P.	0·32	0·40	0·49

—a result which is much in favour of the Diesel engine.

In the course of the discussion Mr. E. R. Dolby (London) remarked that the cost of the oil given in the paper applied to the oil "naked" upon the wharf in London ; but he found that this price was about doubled when the oil was delivered twelve miles away, as it must be put into barrels or a special tank wagon must be used.

Mr. George Wilkinson (Harrogate) expressed the opinion that in the near future there would be a considerable development in the application of internal combustion engines for electric and other purposes. He regretted that they had to purchase these engines abroad, and that there was not a firm in England sufficiently enterprising to take up their manufacture.

Mr. M. Longridge thought that experiments should be made to get rid of the water jacket, using instead an excess of air to keep down the temperature. The Diesel engine presented enormous advantages in some cases.

Professor Lupton (Leeds) remarked that, however excellent the Diesel engine might be, it could never be really used as a substitute for the steam engine. The real interest in this engine was in regard to slow combustion as a gas engine.

Professor Goodman claimed for the Diesel engine that it was a triumph of scientific reasoning. It was the result of the application of theory to practice, and could not have been designed by anyone who had not an adequate scientific education. The economy of the engine was due to the very high compression and the more complete combustion that took place. He wished English engineers could do a little more than they did in careful trials of oil engines. Why should England be behind ? If Germany could produce an engine, surely they could do it.

In the course of further discussion as to the cost of running these engines, etc., by Messrs. M. H. Robinson (Rugby), A. Saxon (Manchester), Lawson (Harrogate), F. H. Livens (Lincoln), and C. Day (Glasgow), members were reminded by the latter that the Diesel engine had been made both in England and in Scotland during its earlier stage of development, and that a Scotch firm had recently undertaken its manufacture.

HIGH-SPEED TOOL STEELS.

Mr. Henry H. Suplee, of New York, supplied a number of notes representing officially verified data as to the use of high-speed tool steels in the works of the Union Pacific Railroad, at Omaha, Nebraska.

These steels are similar in constitution to the Mushet air-hardening steel, the principal difference being that a much higher temperature is used in the tempering process.

The steels contain both chromium and tungsten in varying proportions as well as molybdenum. The method of treatment consists in heating the tool up to about 2,000 deg. F., then cooling rapidly down to about

1,700 deg. F. in a lead bath, and then slowly in air or lime.

These steels, of which the Taylor-White is the best known and earliest example, are able to maintain a cutting edge even when operated at speeds producing a red heat, and in fact unless such speeds and temperatures are maintained they do not give satisfactory results. These tools should be used only for roughing purposes, and the great economy resulting from their use appears when it is found that the forgings can be made with less care as to size, the roughing down to finishing dimension being made more rapidly and economically in the machining processes than in forging.

Samples of chips were shown which were turned from car-wheel tyres at lineal speeds of 5 ft. to 8 ft per minute, the weight of metal removed being about 8 lb. per hour; this was with ordinary tool steel. A spiral turning, from a locomotive tyre, was made with high-speed steel at a speed of 24 ft. per minute, removing 100 lb. to 120 lb. per hour; while a heavy chip was taken at 18 ft. per minute, removing 450 lb. per hour. This latter cut was too heavy for the powering of the lathe, however, and the rate could be maintained for only a short time, but the tool showed no signs of distress.

Further interesting data from the Union Pacific shops was given in a number of tables.

In the course of the discussion the President said he felt that Mr. Suplee had filled a distinct gap in bringing this subject forward. This was the greatest revolution that had happened in his own particular trade and time. He called upon Mr. Joseph Barrow for an expression of opinion.

Mr. Barrow said he was called upon by the President to bless, but he could only curse. He considered, however, that the use of high-speed cutting was advantageous where the speed of tools could be satisfactorily increased from, say, 20 ft. to 60 ft. per minute. Where a high cut had to be taken one should use a high speed, but where a heavy cut was needed the slow speed should be adopted.

Further expressions of opinion were given by Messrs. Christopher James (Leeds), W. Hartnell (Leeds), R. Allen (Bedford), and others.

The author of the paper said his figures were not based upon special tests, as some of the members seemed to think, but were results obtained in ordinary every-day work.

The discussion is further dealt with in our notes on Workshop Practice.

NEW FORM OF FRICTION CLUTCH.

At the second and closing sitting of the Conference, Professor H. S. Hele-Shaw, F.R.S., described his new form of friction clutch in an illustrated paper, of which the following is an abstract:—

The friction clutch is a very old invention, and is probably as familiar to every one in its simplest form as any other machine detail. It is, however, only in recent years that inventors have—in any great numbers—seriously attempted to overcome the defects of the ordinary cone clutch, and their attempts have been attended with such success as to lead to the introduction of a very large number of clutches of moderate power into machinery.

A familiar illustration is the extensive introduction of friction clutches to countershafts in place of the ordinary fast and loose pulley. It might therefore be thought at first that, in such an apparently simple matter, there was very little more to be said and nothing more to be discovered. The importance of the friction clutch, however, justifies a very careful consideration of the problem, and as to whether, in view of the modern developments of motive power, particularly in internal combustion engines and of high-speed machinery of great power, there are not yet improvements possible in this subject.

Where two pieces of machinery, not having the same speed, have to be connected with each other, there would be a shock due to inertia, unless the connection was made by means of a friction clutch, or some equivalent, such as a slipping belt, allowing the two pieces of machinery to gradually come to the same speed. This gradual effect is therefore the primary object of the friction clutch, and how important this object is will be realised when it is remembered that it is impracticable to start any machine instantaneously, for the magnitude of the stresses and strain caused when a machine is set in motion by another, increases with the suddenness of the operation, and all appreciable shock can be obviated by allowing the action to take place gradually.

Stated briefly, the four conditions which seem to be involved in the problem of the friction clutch are:—

(1) It must have sufficient gripping power.

(2) Undue wearing of the surfaces must be avoided.

(3) Provision must be made for conveying away the heat where there is much slipping contact in the clutch.

(4) Motion should be imparted to the driven shaft without shock.

We are thus met at the outset with the contradictory conditions which have made the problem of the friction clutch such a difficult one. The author does not remember seeing in any previous writings on the subject, or in the statement of inventors themselves, the important fact mentioned in condition (3), but it certainly does account for the large number of instances in which friction clutches have failed to give satisfactory results for anything but the smallest powers.

Having classified the various clutches in use, Professor Hele-Shaw observed that the inventions in connection with modifications of these clutches related principally to the mode of obtaining the requisite pressure between the friction surfaces. It might, he considered, be safely said that not one of the clutches mentioned had yet been designed so as to be capable of slipping for more than a very short time without being seriously injured, even if the surfaces in contact were not actually destroyed.

There were plenty of illustrations in mechanical science where it had hitherto been impossible to

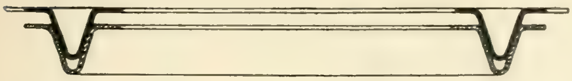


FIG. 1. PAIR OF PLATES SHOWING CLEARANCE DUE TO CORRUGATIONS.

reconcile conflicting conditions, and it was an important question whether the present case formed another example or not.

Proceeding to describe the new clutch, the author continued :—

Suppose a sheet of metal is pressed into a frustum, the section of the corrugation being the frustum of a cone, and that the disc is placed upon another one similarly corrugated. It will be observed that not only do portions of the frusta not make contact with each other, but there is also a space left between the flat portions of the discs. By placing these discs together, as in fig. 1, and turning one alternately to the other, an amount of friction is produced which depends on the acuteness of the angle of the frusta. If a number of these plates are now placed in a box of the type of the "Weston" coupling, so that the plates alternately engage with two sleeves, one connected with the driver and the other with the follower, as in fig. 2, it will be found, first, there is very considerable gripping power ; second, there is a tendency to part rapidly with heat, owing to the separation of the discs of metal.

Dealing with the results of experiments made with corrugated plates of different angles, he said the conclusion arrived at as to the effect was that it was due in part at any rate, to the necessary deviation from the truly circular form of the corrugations in the plates.

Efficient lubrication of the surfaces in contact is ensured by drilling a few large holes in the faces of the corrugations.

Two views of a standard type of clutch for shafts up to 2 in. diameter are shown in fig. 3.

The shaft is divided at A, the outside case, B, being keyed to the left-hand piece of shafting, and driving the set of plates having external driving teeth. The core, C, keyed to the right-hand shaft driving the plates with internal driving teeth. Pressure is applied to the plates as follows : The sliding sleeve, D, containing a coil spring, is fitted with pins which project through the outside case of the clutch ; these pins press against a flat disc, which in turn presses against the plates causing the clutch to drive.

When the operating lever is worked so as to release the plates, the ring, E, encircling the sleeve withdraws the trigger pins from the holes into which they fit ; the spring pressing on the opposite end of the trigger pin causes the trigger to fly up and the clutch is thereby kept out of operation.

By moving the lever so as to force the ring, E, against the trigger, the pin end falls into the hole opposite to it, and the coil spring is then allowed to transmit its pressure to the plates.

Figs. 4 and 5 show the design of an epicyclic reversing gear for a steam turbine of 1,000 h.p., the number of revolutions per minute being 700 to 800. The action of this type of reversing gear may be made as quick or slow as desired, but with the fairly heavy fly-wheel attached to the gear shown, it has been found possible to change from full speed in one direction to full speed in the opposite direction in five seconds.

It was mentioned that the application which led to the invention of the new clutch was in connection with the motor-car, for which purpose it is most difficult to secure a satisfactory clutch.

The paper was followed by a practical demonstration of the working of the new clutch. The Leeds Corporation had lent one of their motors for the purpose of supplying the gearing with motive power.

Professor Arnold Lupton (Leeds) remarked that the friction clutch described by Professor Hele-Shaw seemed to be what the mining world was wanting. In driving and hauling in mines, clutches were of course universal, or nearly so, but the beauty of the clutch referred to was that it would enable engineers to vary the speed of ropes on difficult turns of underground road —reducing or increasing it—without altering the speed of the electric motor itself. He believed the new development would prove of great advantage to those who were connected with mines. "I must," said Professor Lupton, "congratulate Professor Hele-Shaw on the work he has done, and hope we shall hear more of it in future."

In the course of further discussion Mr. Barnes, of Liverpool, said the new clutch was one which was bound to have a great effect upon every branch of engineering in which they were used, and it was hard to say to which branch they did not apply.

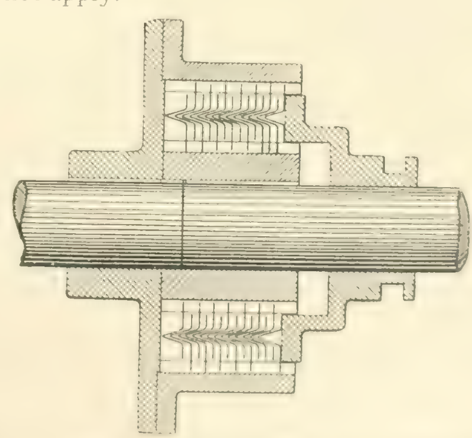


FIG. 2. ORDINARY ARRANGEMENT OF CORRUGATED PLATES.

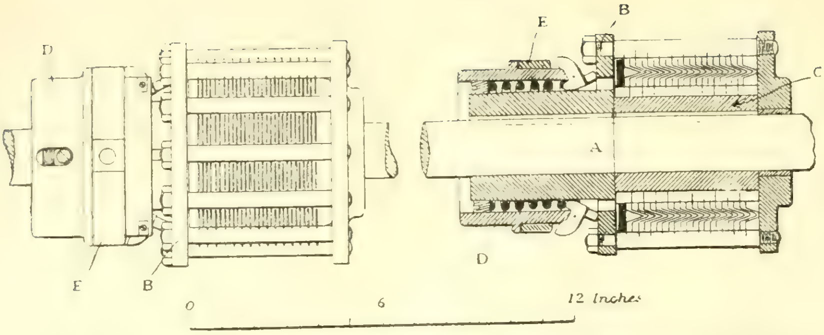


FIG. 3. TYPE OF OPEN CLUTCH WITH AIR COOLING, SHOWING TRIGGERS FOR HOLDING OFF PRESSURE.

ECONOMY OF FUEL IN ELECTRIC GENERATING STATIONS.

An instructive paper on the above subject was contributed by Mr. Henry McLaren, of Leeds.

The first point that attracts attention is the great difference in cost per unit generated in these stations. They are located in various parts of the country; some are condensing, others partly condensing, or non-condensing stations, the price paid for coal varies largely, and different systems of supply are used. All these considerations affect the costs.

Engineers would naturally expect that condensing stations would show a better fuel economy than non-condensing, both for tram and lighting purposes, but so far as lighting only is concerned, it is just the reverse; the average, both in fuel and works costs, is considerably in favour of non-condensing stations. Where trams are added to lighting, the condensing plants show a better economy than non-condensing, but in all cases the partly condensing station is the most economical both in fuel and works costs.

Comparing twenty-two metropolitan lighting stations it is shown that the non-condensing stations produce current at 18 per cent., and the partly condensing at 21 per cent. less cost than the condensing stations. For fuel only, the saving in favour of non-condensing and partly condensing plants is about 14 per cent. and 17 per cent. respectively.

Considering 116 small provincial lighting stations, having the advantage of cheaper coal and labour as compared with the Metropolitan stations, the average cost of producing current is 18 per cent. less. Here again the non-condensing and partly condensing stations are more economical than the condensing.

In thirty-two provincial stations supplying current both for lighting and tramways, however, the condensing plants are found to be more economical than the non-condensing by about 9 per cent. in works' cost and 19 per cent. in coal, but the partly condensing stations are still better than the condensing, showing an economy of 23 per cent. in works' cost and nearly 4 per cent. in fuel.

It is surprising to find that at least two of the lighting stations, Leeds and Edinburgh, deliver current at the consumers' meters at 9 per cent. lower average cost than the four power stations of Blackpool and Fleetwood, Dublin, Glasgow, and Hull average at their switchboards. Glasgow, the most economical of the four power houses, with an annual output of 10,000,000 units and a tramway load factor, delivers current at the switchboard at a cost of 0·6d, per unit works' costs, whereas Leeds lighting stations, with only 3,000,000 units output and a lighting load factor shows a works' costs of 0·62d. per unit, including the heavy loss in the mains.

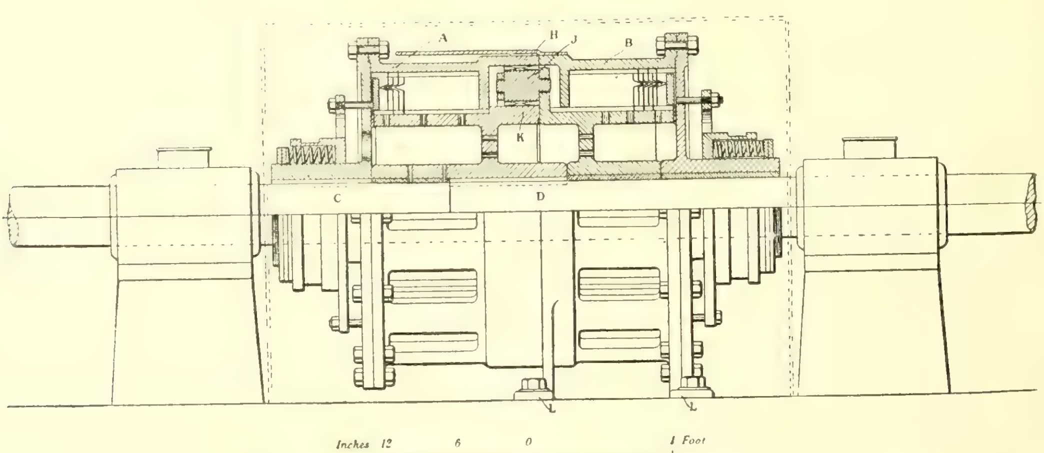


FIG. 4. DESIGN FOR 1,000-H.P. REVERSING CLUTCH.

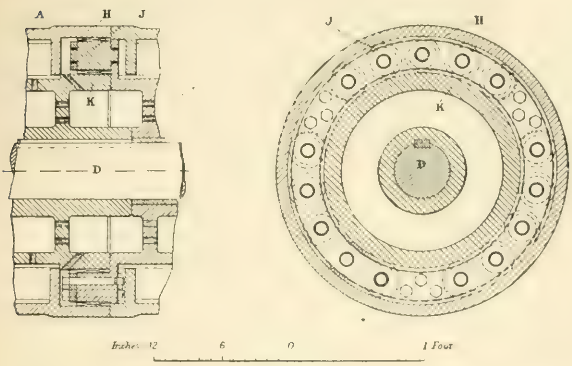


FIG. 5. EPICYCLIC GEAR FOR REVERSING CLUTCH SHOWN IN FIG. 4.

METROPOLITAN LOSSES.

It would appear that the Metropolitan condensing stations, after allowing 30 per cent. for outside losses and banking fires, etc., were using at least twice the amount of fuel that economical plants ought to require. They generated during the year over 41,000,000 units, at a cost for fuel of over £200,000. A very large percentage of this amount could have been saved by the use of well-managed, economical generating plant. It must be remembered, however, that the most of these stations were pioneers in the electric lighting industry of this country. Each extension was in a measure a large experiment, and they have had to contend with difficulties too numerous to mention.

Taking the average station throughout the country, there is great room for improvement; on the other hand, one finds a few stations that leave nothing to be desired; some remarkably economical results are recorded even in small provincial stations.

PARTLY CONDENSING STATIONS.

It is rather remarkable that the partly-condensing stations show the best average economy. Partly condensing is a very vague term; it may mean one engine in ten is non-condensing, or *vice versa*. No doubt, most of them might be classed as condensing stations. Without more exact data it is impossible to come to any definite conclusion as to the reason for this good average economy.

The statistical tables produced show that in lighting stations the non-condensing engines beat the condensing by 13 per cent. in fuel economy; this is the average over the whole country, 13 + 25 = 38 per cent. to be accounted for to bring matters as they ought to be. Uneconomical, three-crank compound, tandem, condensing engines, largely used in lighting stations, no doubt account for some of this, and, as already shown, separate condensing plants are also steam wasters.

CAUSE OF STEAM LOSSES.

The steam losses in electric generating engines are mostly due to valve or piston leakage; mainly the former. This applies more especially to condensing stations using engines fitted with piston valves; unless these are very carefully looked after, heavy leakage is likely to occur, the steam passing direct to the condenser. In non-condensing engines the exhaust pipe usually gives warning of leaky valves. Many station engineers do not appear to realise how serious this loss may be, and allow their piston-valves to run in a very leaky condition. Others give this matter most careful attention, and are well rewarded for their trouble; in fact, some of the most economical non-condensing stations are fitted throughout with piston-valve engines, carefully looked after and kept steam-tight. Balanced slide-valves, and valves of the Corliss type, having some pressure on the back to keep them up to the port faces, require much less attention, and will run for many years practically steam-tight.

Two recent tests of condensing engines (in different stations) fitted with piston-valves, disclosed the fact that they required over 45 lb. and 50 lb. of steam per kilowatt-hour respectively. When previously tested the consumption was about 30 lb. per kilowatt in each case. Outwardly they appeared to be running as well as ever.

Coal to the value of £839,613 was used in the 177 stations given in the tables, during the year under review. It is safe to assume that £100,000 was lost in engine leakages alone. There is no doubt it would pay to employ an engineer in each of the larger stations to do nothing else but make tests and report on fuel losses with a view to their remedy.

BOILER HOUSE PLANT.

There are great differences in the qualities of steam generated by boilers. Engine-builders find much less difficulty in getting their guarantee figures from the honest steam of the Lancashire or other cylindrical boiler than they do from the high-pressure "Scotch mist" given off by the now fashionable box of water pipes. In lighting stations there are great fluctuations in the demand for steam. Only those who really understand the "art" of firing, can appreciate the difficulty of working mechanical stokers with economy under such conditions. Extra grate area may be the salvation of the "tyro" at the higher loads, but with such men, it is fatal to economy at the lighter loads, especially when steam-jets to force the draught are used.

An efficient method of forced draught is a decided advantage in lighting stations, if it is properly used, for it enables steam to be maintained over the peak of the load.

Superheating, especially when piston-valve engines are used, shows a good steam economy, but the saving in fuel is not so marked. In lighting stations its proper regulation is rather difficult. The extra wear and tear on the main engines, and on the superheaters themselves, are items that have to be considered.

TENDENCY TO IMPROVEMENT.

It is encouraging to note from recently published returns that the costs in various stations throughout the country show a decided tendency to improvement.

This is partly owing to cheaper coal, but there is also a healthy rivalry between station engineers, stimulated no doubt, by the *Electrical Times*, publishing their results. This should in time bring the electric generating stations into the front rank as regards economy of fuel.

The discussion was contributed to by Messrs. D. Halpin (London), G. Wilkinson (Harrogate), C. Forgan (London), J. D. Bailie (Leeds), T. L. Miller (Liverpool), M. Robinson (Rugby), M. Longridge (Manchester), and A. Saxon (Manchester), Prof. Lupton, and others.

The meeting closed with the usual votes of thanks.

VISITS TO WORKS.

An excellent programme of visits to the iron and other works for which Leeds is so justly famous, had been arranged, and the attendances showed that these outdoor functions were considered by no means the least interesting part of the proceedings.

A large share of attention was taken up by the City Electric Lighting and Power Station, the Refuse Destructor, Corporation Subway, and the Yorkshire College.

Among the machines finished or in progress at the works of Messrs. Joshua Buckton and Co. were the following, representing recent developments :—

Double-cutting table planing machine 8 ft. by 8 ft. by 24 ft., with power feed and tool-box traversing motion ; standard 12-in. lathe for high-speed cutting ; two-spindle radial drill ; locomotive crank-axle profile slotting machine ; four-spindle rail drilling machine ; vertical and horizontal planer with fixed table, and moving upright ; chain and anchor testing plant ; 300-ton universal testing machine ; vertical testing machines ; and 4½ in. square cold billet shears.

At the Farnley Iron Works, members had an opportunity of inspecting the special process of manufacturing the " best Yorkshire " iron, commencing with the use of cold-blast furnaces for melting the ore.

Another interesting process to be seen here is the manufacture of fireclay goods. The fireclay found under the neighbouring hills is of a highly refractory nature, and affords material not only for fire-bricks and retorts, but also for the well-known glazed bricks for which Leeds has gained a wide reputation.

The principal work in progress at the shops of Messrs. John Fowler and Co. was the manufacture of ploughing and traction engines, steam road-rollers, large winding engines and electrical plant. The number of men employed is about 1,500.

The works of Messrs. Greenwood and Batley, covering 31,594 square yards, and employing some 2,000 men, offered many points of interest, the departments being severally devoted to special and general machine tool making, oil mill and general millwright work, textile machinery, electrical plant, turbines, ordnance, and sewing machines.

Members visiting the Sun Foundry of Messrs. Hathorn, Davey and Co. had an opportunity of seeing in an advanced stage of construction (besides other sets of pumping machinery for water works and mines), two sets of vertical, triple-expansion pumping engines for the British Government, and the Rosario de Santa Fé Waterworks respectively ; a compound engine, actuating a centrifugal pump with horizontal axis, to raise 140 tons of water per minute a vertical height of 13 ft., for draining the Fen district ; and two vertical engines with overhead beams, to raise water out of a well and deliver it into a tank 100 ft. above ground level, for the London County Council.

Locomotive building as well as general engineering could be studied in the works of Messrs. Hudswell, Clarke and Co., which are lighted and driven by electricity, and give employment to 400 or 500 hands.

The Hunslet Engine Company were found to be making considerable extensions of their works, the most important item being a new boiler shop, about 200 ft. long by 53 ft. wide, which will be equipped with efficient and up-to-date tools.

Traction engines and wagons, steam ploughing engines and electric generating engines for home and abroad were seen in process of manufacture at the works of Messrs. J. and H. McLaren, which give employment to some 230 men. The largest engine constructed by this firm was supplied to the Leeds Corporation last year for generating electricity at the Whitehall Road Station. It is a high speed enclosed triple-expansion engine of 3,000 i.h.p.

One of the most instructive visits was that which was paid to the Leeds Steel Works of Messrs. Walter Scott, Ltd. These occupy twenty-five acres in one of the busiest parts of Leeds, and employ about 1,350 men. They comprise a blast furnace plant, basic Bessemer steel department, rolling mills, girder constructional and tram-rail finishing yards ; also a basic slag artificial manure plant.

The Leeds Steel Works claim to be the largest makers of girder tram-rails in Great Britain. Forty-four different sections of these rails have been rolled, varying in size and weight from 5 in. by 5 in. at 65 lb. per yard to 7 in. by 7½ in. at 108 lb. per yard. Upwards of fifty motors, ranging from 1·5 to 50 h.p. each, have been supplied by Messrs. Greenwood and Batley, of Leeds. These are of enclosed ventilated direct-current type. The whole of the electrical plant is giving satisfaction, and arrangements are being made for the fixing of fifty other motors in place of small engines, whereby a considerable economy in fuel, greater efficiency, and less liability to stoppage for repairs will be realised. New repair shops, 250 ft. long by 38 ft. broad, have been erected for greater convenience in carrying out the repairs incidental to the iron and steel works.

Messrs. E. Green and Son, of Wakefield, invited the members to view their economiser works, which

have been entirely re-organised and employ about 1,000 men. Other works thrown open to their inspection included those of Messrs. Clayton, Son and Co., Deigton's Patent Flue and Tube Company, Messrs. Graham, Morton and Co., Joshua Buckton and Co., Kitson and Co., Tannett, Walker and Co., and the Frodingham Iron and Steel Works.

For the above visits the tramcars were freely placed at the disposal of members by the Leeds Corporation.

The second day's programme included a visit to the Great Northern Railway's Wagon Works at Doncaster, which was largely taken advantage of, and on the concluding day excursions were available for Ripon and Fountains Abbey or York.

THE ANNUAL DINNER.

At the annual dinner of the Institution held at the Town Hall, the President, Mr. J. Hartley Wicksteed, presided over a large and influential gathering.

The usual loyal toasts having been honoured at the conclusion of the dinner, Sir E. H. Carbutt, Bart., gave "The Houses of Parliament," Mr. R. H. Barran, M.P., responding.

The Lord Mayor, acknowledging the toast ot "The City and Trade of Leeds," which had been proposed by Mr. W. H. Maw, observed that in recent years Leeds had made phenomenal progress. At the beginning of last century Leeds had a population of some 53,000, but to-day it inhabitants numbered 440,000, and its increase in this respect had during the last decade been greater than that of any other city in England. The trades of Leeds, being numerous, contributed to its progress. Improvements in the city continued to be made. Notwithstanding the cry that the rates grew higher, Leeds still progressed, and he believed it was destined to occupy a very high position among the cities of the kingdom.

Mr. E. Windsor Richards, in submitting the toast of "The Reception Committee and Our Guests," said he thought there must be many young engineers who were visiting Leeds for the first time under the guidance of the Institution, and this being so he would like to point out that they were in the home of the "Best Yorkshire" Iron, a manufacture which had been in this district for more than a hundred years. Not only this, but they were in the home of the largest and best engineering works in the country.

Sir James Kitson replying, referred to the "unproductive expenditure" of £250,000,000 in South Africa. He did not enter into the question of whether it was a necessary or an unnecessary policy, but as a commercial man he wished to point out that he believed it was owing to the fact that this capital, which would ordinarily have been used in the development of new works of a productive character, would have given that employment to the engineers of the district which is now, unhappily, lacking. He ventured to put this before them in order that he might assert that it is not owing to the lack of intelligence, of capacity, of the want of development of their means of production that there was, for the moment, somewhat of a decline in the production of the mechanical arts. After various reminiscences, he said he believed there were brighter times for Leeds and the West Riding than he had sketched with the development of the great engineering school in the Yorkshire College. Under Professor Goodman and the able professors who preceded him, the school had done a great work and was assisting to forward Leeds in the path of progress.

Col. F. W. Tannett-Walker also replied. Speaking of the training of young engineers, he said, that if they could make the lads understand that all that was asked from them was energy, industry, and reasonable obedience, and an absolute determination to do the job given them by the man in command—if they could teach them that, and bring them up as mechanics fully equipped, they would have something better than any American quick-speed steel, or better almost than any college product.

Mr. A. G. Lupton, in giving "The Institution of Mechanical Engineers," attributed a great deal of the success of the engineering department of the Yorkshire College to the great interest which had been taken in it by the Engineering Committee. He considered that an institution which was working in the midst of the industries which it served was worthy of the support which it had hitherto received. The engineering department of the College was crowded with students, and with the university charter they hoped to see a very large development in electrical and other engineering.

The President acknowledged the toast, incidentally remarking that the importance of the Institution was reflected in its membership. During the evening popular selections of music were rendered by the County String Band.

RECEPTION.

The social functions connected with the meeting also included a well-attended reception in the Leeds Art Gallery by invitation of the Lord Mayor and Lady Mayoress.

THE MEMBERS PHOTOGRAPHED.

On the first day of the meeting the members were grouped on the steps of the Town Hall and photographed. The photograph has been reproduced, and will be found on pages 232-233.

SOME FOUNDRY PRACTICE AT SOTTEVILLE LOCOMOTIVE WORKS.

BY

CHARLES R. KING.

The author writes in a practical manner of the locomotive works at Sotteville, France, at which a number of interesting mechanical processes for small foundry work are carried on, including, besides hydraulic moulding (or ramming) and assembling machines for repetition work, a series of special pattern casts for moulds and for cores formed variously of plaster, of plaster sheathed in zinc, and sometimes made entirely of metal.—ED.

THE largest work done at the locomotive works of the French Western Railway at Sotteville, near Rouen, is generally propeller screws for the company's steamers and also locomotive work, such as pairs of low-pressure cylinders, cylinder-caissons for bracing the frames between pairs of outside cylinders, etc. The loam moulds for the first-named castings are formed within pits in the shop floor by the aid of sweeps, and the latter, moulded from patterns as usual, are also prepared in the floor; surface work with brick-built moulds supported by metal curbing or flasks for transport to the pits not being usually employed here for large pieces.

The moulding floor of the iron foundry has an area of 4,750 square feet, and the whole area of the shops belonging to the foundry is 9,470 square feet. In the iron foundry there is only one cupola, which answers for all present requirements. This latter is located about the mid-length of the building, outside, along with the charging floor. Its capacity is 4,000 lb., and it yields from five to six tons of metal daily. There are about seventy men employed in this foundry.

A great quantity of medium-sized locomotive pieces are cast in green sand by the usual methods, as, for instance, brake-cylinders, cylinders for the making of piston-rings, blast pipes, regulator stand pipes, axle boxes, etc., but in the casting of these the visitor notices very little that differs from the practices employed in other foundries.

It is, above all, for small pieces which have to be produced in large quantities, such as parts for brake equipment, draft and buffing attachments, the lower halves of axle-boxes, brackets, and wagon fittings in general, that it is necessary to dispense with the labour of moulders, and also with the cost of numerous patterns; consequently, repetition machines are employed, and in the place of moulds or patterns, stereotype-casts are often used.

The particular means adopted for the rapid production of pieces on this multiple system as followed at Sotteville, are due to the collaboration of Messrs. Saillot and Vignerot, formerly shop manager and shop foreman, respectively, at these works.

The machines will be described first, in order to thus facilitate the explanation of the special stereotyping processes.

The hydraulic-moulding press, or ramming-up machine, is destined for mechanical moulding upon plaster and metal casts or matrices, its purpose being to effect the gradual and complete squeezing-up of the sand, thus obtaining a clean, sharp, and solidly cohesive mould, and permitting the formation of vertical cores, while

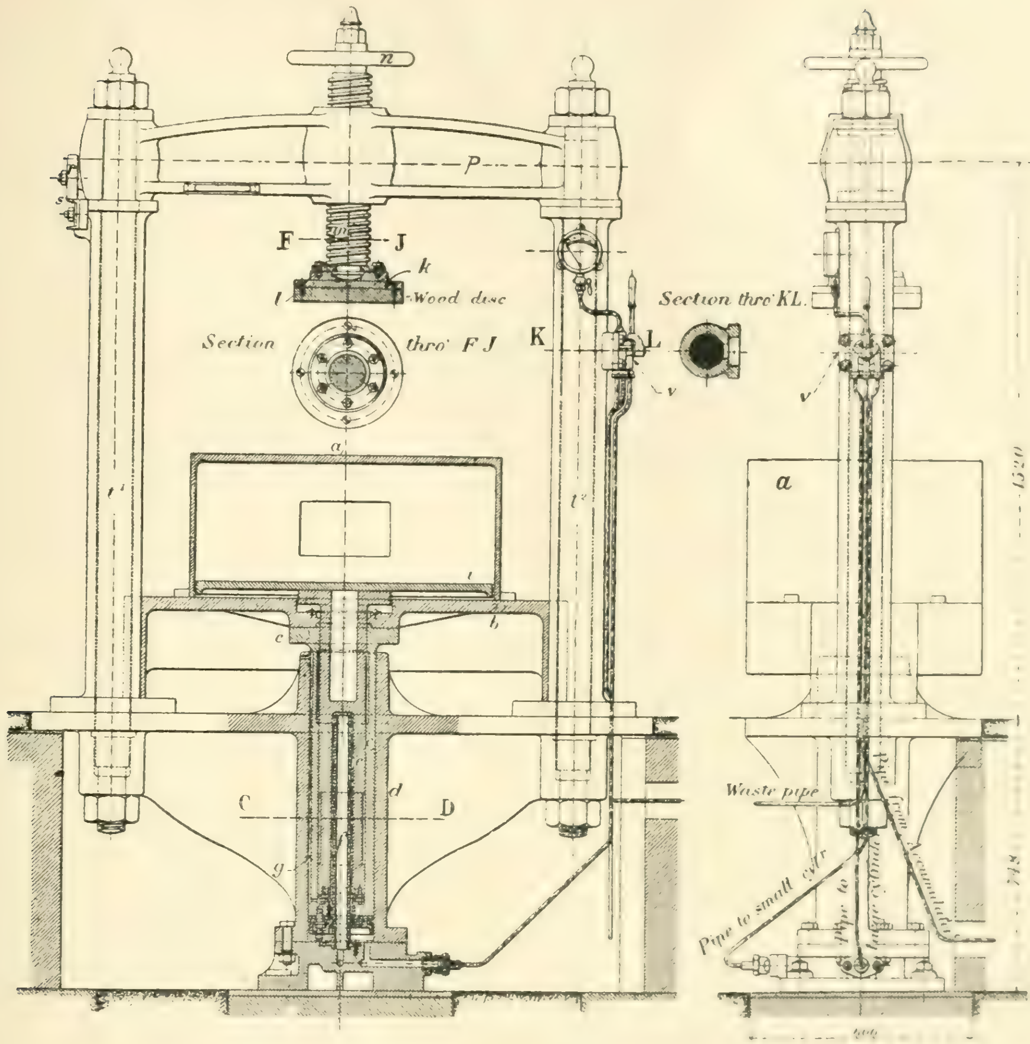


FIG. 1. ELEVATION. FIG. 2. SIDE VIEW.

HYDRAULIC MOULDING MACHINE.

disaggregation of the thin edges of the mould, when withdrawing it from the cast, is avoided by the use of retainers, stripping-plates, or supports, with lifters or ejectors for the cores. The means of making and employing these latter adjuncts will be described presently.

The hydraulic machine is illustrated by the sections (figs. 1 to 12).

It is composed of two essential parts, the one for moulding or ramming the sand, and the other for the removal of the mould. For each operation there is a distinct hydraulic piston, the larger serving for the first operation, which requires considerable effort, while the second operation, which necessitates a relatively low pressure, is effected by a smaller piston, with a consequent economy of water.

For moulding, the moulding table, A, is driven up by the larger or outside piston, C, while the adjustable screw plate, K, is operated above the moulding flask by hand-screw. Lifting of the mould is effected by the platen operated by the second, or smaller, inside piston, E.

The method of its operation is as follows: To make the mould the plaster cast is placed upon the moulding table, A, and covered with

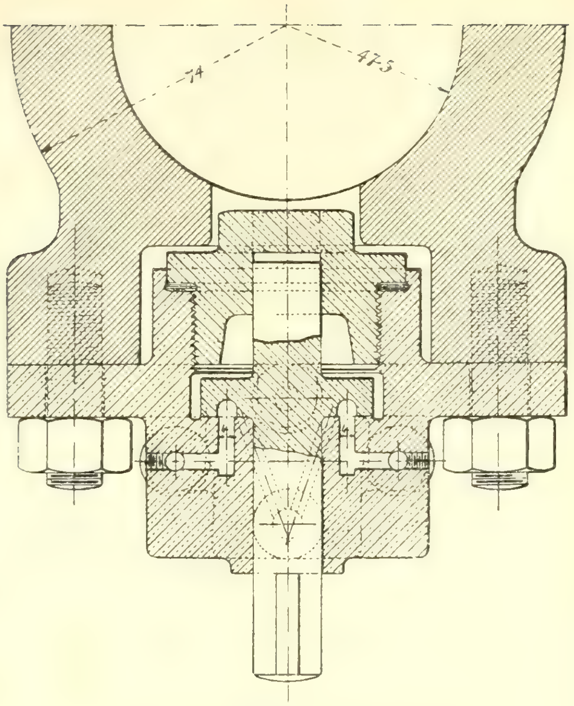


FIG. 7. SECTION THROUGH E, F,

a circular flask filled up with the sand for the impression; the adjustable screw-plate, K, is then swung over the table (see fig.) and brought down upon the sand, and a valve opened until the outer piston, C, has exerted sufficient pressure for the ramming of the sand on the cast.

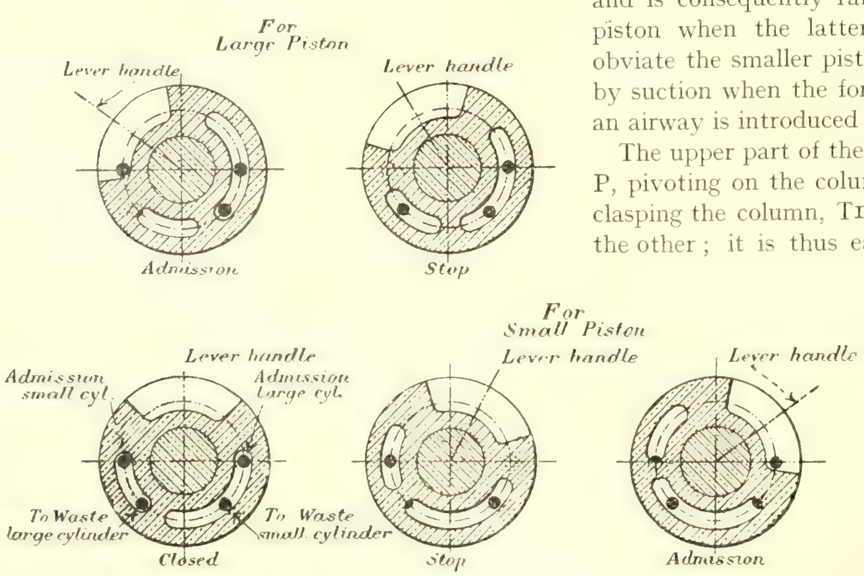
Upon the casts are fixed nipples, or dowels, which correspond precisely with the guide holes of the flasks in which the moulds are formed, so that for the assemblage of the two halves of a given mould, it is only necessary to see that the guide holes in corresponding flasks be in exact register; and this is done at the assembling machine in the manner to be described hereafter.

For turning out the mould from the cast the platen, *i*, is thrust up by the inner piston, E. Upon this platen are fixed four pillars traversing the table, A, by holes drilled therein. While the mould is being removed from the cast, these pillars serve to raise the flask along with the mould retainers, or stripping plates, and the ejectors, or lifters, of vertical cores.

The details of the machine are fairly shown by the sections. It will be observed that the moulding table, A, consists of a hollow box carried upon a cast iron plate working up and down between the two main columns, bolted to the bed of the machine, and with which latter the hydraulic cylinder, D, is cast in one piece.

The pistons in this vertical cylinder are concentric. Water arrives by the vertical standpipe of bronze, F, under the middle, or mould-lifting, piston, which, when not at work, rests on the bottom of the larger, or outside, piston, and is consequently raised along with the big piston when the latter is ramming. But to obviate the smaller piston lifting the larger one by suction when the former should work alone, an airway is introduced at *g*.

The upper part of the machine carries a beam, P, pivoting on the columns T2 at one end, and clasping the column, T1, by means of a jaw at the other; it is thus easily swung out of the way for taking off the moulds. To ensure easy working of this pivoting beam it is carried upon ball bearings. The overhanging weight of this massive beam is supported at the opposite extremity, Q, by means of a roller, R, travelling



FIGS. 8 TO 12. VARIOUS POSITIONS OF WATER VALVE.

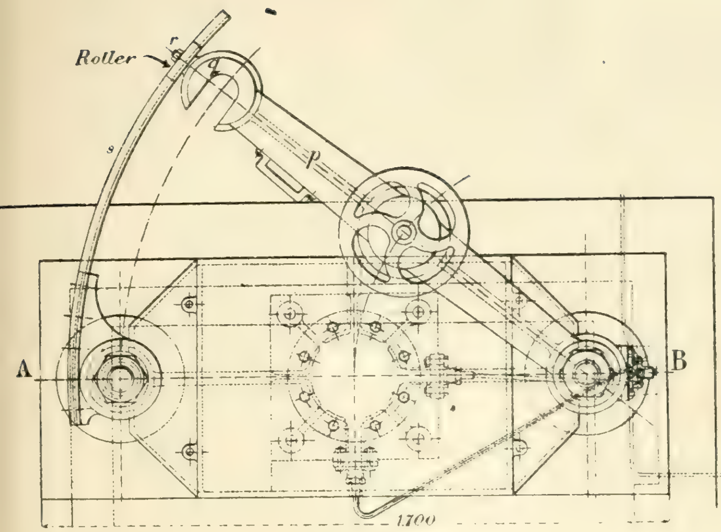


FIG. 3. PLAN.

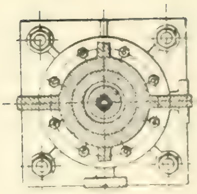


FIG. 4. SECTIONAL PLAN OF PISTONS AT C, D. (FIG. 1.)

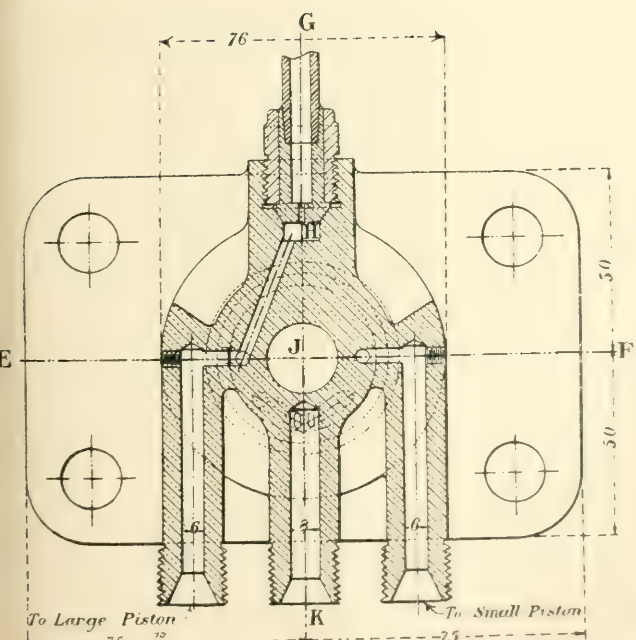


FIG. 6. SECTION THROUGH A, B, C, D.

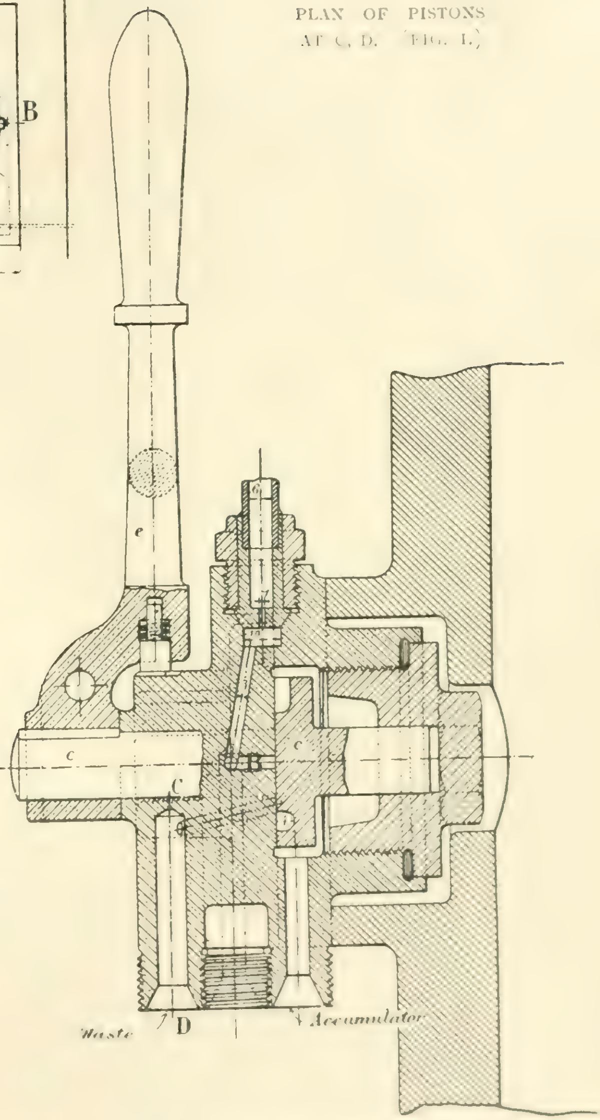
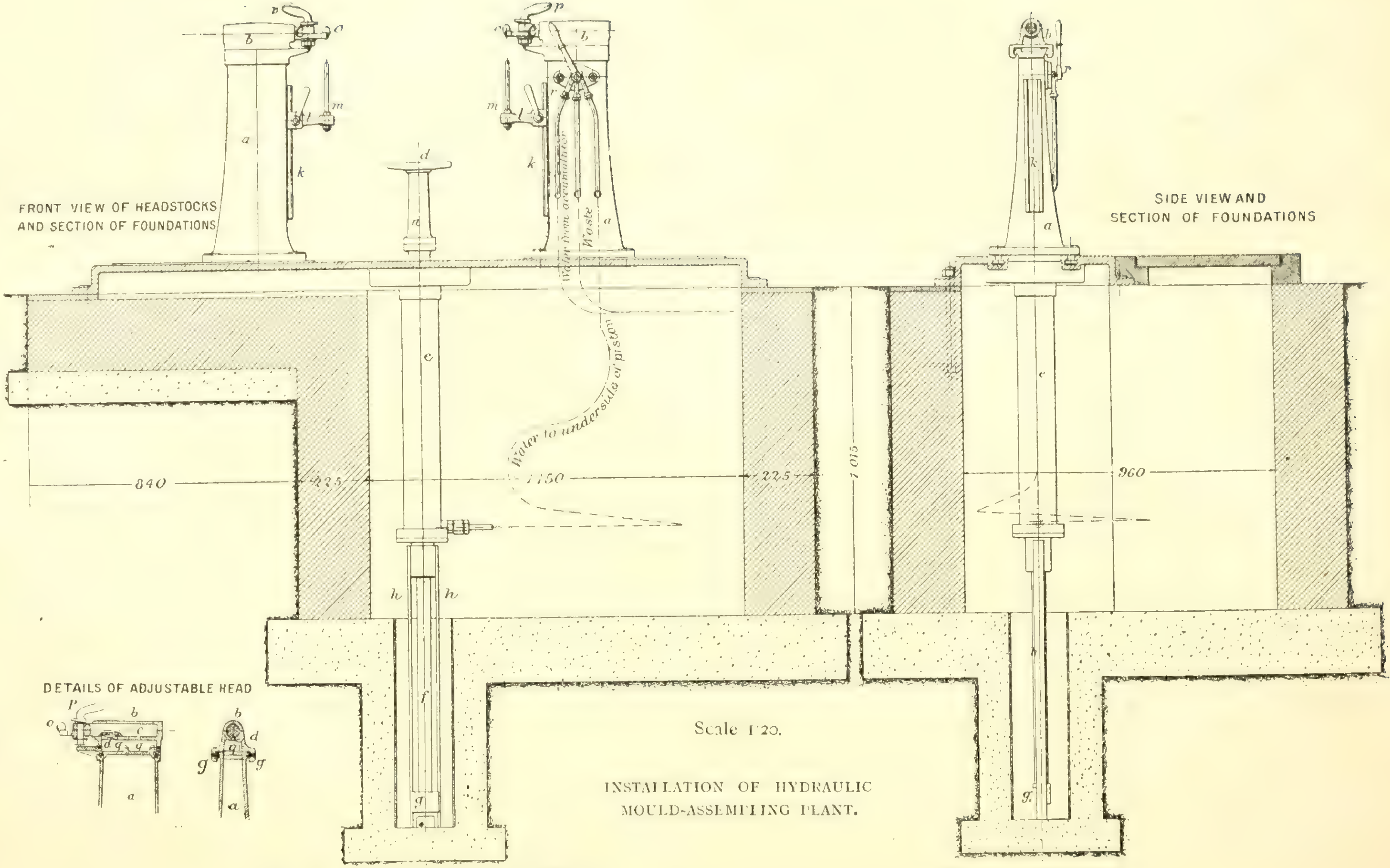


FIG. 5. VALVE OF HYDRAULIC MOULDING MACHINE SECTION THROUGH G, H, I, J, K.

Scale 1:2.



Scale 1:20.

INSTALLATION OF HYDRAULIC
MOULD-ASSEMBLING PLANT.

FIG. 13. FRONT VIEW OF HEADSTOCKS
AND SECTION OF FOUNDATIONS.

FIG. 14. SIDE VIEW.

on a quadrant, S, screwed to a wing support on the upper end of the second column, T1.

It will be noted that the plate, K, carrying a wooden disc, L, can be screwed down on to the sand by the screw, M, operated bythe hand-wheel, N.

The control of the water by means of one lever, E, is very well arranged, as will be evident from an examination of the details of the four-way valve (figs. 5 to 7), and which has the following effects : (1) admission of water from accumulator ; (2) admission to the large cylinder ; (3) admission to the small cylinder ; (4) discharge of pressure to the waste pipe.

The lever, E, regulates the valve, C, and the different positions assumed by the valve are shown by the small sectional views (8 to 12).

The assembling machine (fig. 13), serves for combining the flasks, and also, when pouring in furrows, to turn the latter out of the flasks. This machine, of which fig. 14 gives sections, is indispensable for green moulding, it being the only means for centring the two flasks of a given mould in absolute register. It consists of two headstocks, AA, adjustable along the surface of a floor bed plate for different sizes of flasks, and each one fitted at its upper extremity with a sliding head, BB, with a carrier stud, C, at the inside of which is a nipple, O, serving to receive the lug of the flask at either side, and provided with a clamping handle, P, for securing the flask. The carrier stud, C, is maintained in place by the feather key, D (shown in the details). The heads, BB, slide in the direction of their length upon surfaces planed on top of the headstocks, and travelling within the limit formed by the stops, QQ, that are screwed to the latter. To allow for wear the sliding surfaces are constituted by liners, GG (details), which can be readily replaced whenever required. The sliding heads, or poppets, can be clamped to their beds by means of screws.

A vertical slide face, K (fig. 14), is cast upon each of the headstocks, and to each of these is clamped, wherever required, the bracket carrier, L, with the spits, M, for receiving the lower flask when it has been emptied of its mould.

The platen, D (fig. 14), of the hydraulic piston is centred between the two headstocks. The hydraulic cylinder, E, located below the floor, forms a part of the bed-plate of the machine. To ensure the parallel working of the piston, vertically, it is lengthened by means of a rod, F, fitted with a collar, G, sliding between two guide bars, H, formed of flat strips of iron fixed, above, to the main bed, and, below, to the masonry foundation of the installation.

Water is admitted to the piston by a three-way cock, R, controlled by a lever, and arranged for: (1) admission ; (2) release ; (3) partial release—in the latter case the piston stopping at any desired position of its stroke.

The work proceeds as follows : The flask to be assembled is placed in the machine with its lugs hooked on to the nipples of the carrier studs, and water is applied so that the platen lifts the flask off the nipples. The sliding heads are now pushed back to allow the flask to be lowered on to the spits below.. This operation is again repeated for the second, or upper, half of the mould, and the two flasks are thus accurately combined on the same spits, ready for the removal thence of the flasks for the final adjustment, venting, and pouring of the moulds.

Unflasking, or *demottage*, is performed by placing the upper flask on the nipples of the carrier studs, and clamping it in that position by means of the handles before referred to, while the lower flask rests upon the platen of the machine.

Water is then applied, and the mould is disengaged from the flasks, the upper flask remaining fixed above, while the lower one drops on to the spit brackets, as shown in the view (fig.13).

The round flasks for "mottes," as shown in the engravings, are iron castings bored internally, and weighing thirty pounds upwards.

These repetition machines have proved so successful that a set of them have also been installed in the marine engine and locomotive building works of Ansaldo, at Sampierdarena (Italy), where they give much satisfaction.

(*To be continued.*)

AN IDEAL PLANNING DEPARTMENT.

BY

FREDERICK W. TAYLOR.

In the course of a paper on "Shop Management," presented at the American Society of Mechanical Engineers, Mr. Frederick W. Taylor urges that the leading object in management, namely, high wages and a low labour cost, can best be obtained by including the idea of a "daily task" throughout the field of management. The adoption of this idea involves (at least, in the case of an establishment doing intricate work) the abandonment of individual or personal management, and the substitution of a planning department to do all the detail of the work of management. An outline is given of an ideal planning department.—ED.

MODERN engineering can almost be called an exact science; each year removes it further from guess work and from rule of thumb methods, and establishes it more firmly upon the foundation of fixed principles.

The writer feels that management is also destined to become more of an art, and that many of the elements which are now believed to be outside the field of exact knowledge will soon be standardised, tabulated, accepted, and used, as are now the many elements of engineering. Management will be studied as an art, and will rest upon well-recognised, clearly defined, and fixed principles, instead of depending upon more or less hazy ideas received from a limited observation of the few organisations with which the individual may have come in contact. There will, of course, be various successful types, and the application of the underlying principles must be modified to suit each particular case. The first object in management is to unite high wages with a low labour cost. The writer believes that this object can be most easily attained by the application of the following principles:—

First.—A LARGE DAILY TASK.

Each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague nor indefinite, but should be circumscribed carefully and completely, and should not be easy to accomplish.

Second.—STANDARD CONDITIONS.

Each man's task should call for a full day's work, and at the same time the workman should be given such conditions and appliances as will enable him to accomplish his task with certainty.

Third.—HIGH PAY FOR SUCCESS.

He should be sure of large pay when he accomplishes his task.

Fourth.—LOSS IN CASE OF FAILURE.

When he fails he should be sure that sooner or later he will be the loser by it.

When an establishment has reached an advanced state of organisation, in many cases a fifth element should be added, namely: the task should be made so difficult that it can only be accomplished by a first-class man.

There is nothing new nor startling about any of these principles, and yet it will be difficult to find a shop in which they are not daily violated over and over again. They call, however, for a greater departure from the ordinary types of organisation than would at first appear. In the case, for instance, of a machine shop doing miscellaneous work, in order to assign daily to each man a carefully measured task, a special planning department is required to lay out all of the work at least one day ahead. All orders must be given to the men in detail in writing; and in order to lay out the next day's work, and plan the entire progress of work through the shop, daily returns must be made by the men to the planning department, in writing, showing just what has been done. Before each casting or forging arrives in the shop the exact route which it is to take from machine to machine should be laid out. An instruction card for each operation must be written out stating in detail just how each operation on every piece of work is to be done and the time required to do it, the drawing number, any special tools, jigs, or appliances required, etc. Before the four principles above referred to can be successfully

applied, it is also necessary in most shops to make important physical changes. All of the small details in the shop, which are usually regarded as of little importance, and are left to be regulated according to the individual taste of the workman, or, at best, of the foreman, must be thoroughly and carefully standardised, such details, for instance, as the care and tightening of the belts; the exact shape and quality of each cutting tool; the establishment of a complete toolroom from which properly ground tools, as well as jigs, templets, drawings, etc., are issued under a good check system, etc.; and as a matter of importance (in fact, as the foundation of modern management) an accurate study of "unit times" must be made by one or more men connected with the planning department, and each machine tool must be standardised and a table or slide rule constructed for it, showing how to run it to the best advantage.

At first view, the running of a planning department, together with the other innovations, would appear to involve a large amount of additional work and expense, and the most natural question would be is whether the increased efficiency of the shop more than offsets this outlay. It must be borne in mind, however, that, with the exception of the study of unit times, there is hardly a single item of work done in the planning department which is not already being done in the shop. Establishing a planning department merely concentrates the planning and much other brain-work in a few men especially fitted for their task and trained in their especial lines, instead of having it done, as heretofore, in most cases by high priced mechanics, well fitted to work at their trades but poorly trained for work more or less clerical in its nature.

There is a close analogy between the methods of modern engineering and this type of management. Engineering now centres in the drafting room as modern management does in the planning department. The old style engineering had all the appearance of simplicity and economy, while modern engineering has all the appearance of complication and extravagance, with its multitude of drawings, and the amount of study and work which is put into each detail; and its corps of draughtsmen, all of whom would be sneered at by the old engineer as "non-producers." For the same reason, modern management, with its minute time study and a managing department in which each operation is carefully planned, with its many written orders and its apparent red tape, looks like a waste of money; while the ordinary management in which the planning is mainly done by the workmen themselves, with the help of one or two foremen, seems simple and economical in the extreme. The writer, however, while still a young man, had all lingering doubt as to the value of a drafting room dispelled by seeing the chief engineer, the foreman of the machine shop, the foreman of the foundry, and one or two workmen, in one of our large and successful engineering establishments of the old school, stand over the cylinder of an engine which was being built, with chalk and dividers, and discuss for more than an hour the proper size and location of the studs for fastening on the cylinder head. This was simplicity, but not economy. About the same time he became thoroughly convinced of the necessity and economy of a planning department with time study, and with written instruction cards and returns. He saw over and over again a workman shut down his machine and hunt up the foreman to inquire, perhaps, what work to put into his machine next, and then chase around the shop to find it, or to have a special tool or templet looked up or made. He saw workmen carefully nursing their jobs by the hour, and doing next to nothing to avoid making a record, and he was even more forcibly convinced of the necessity for a change while he was still working as a machinist by being ordered by the other men to slow down to half speed under penalty of being thrown over the fence.

No one now doubts the economy of the drafting room, and the writer predicts that twenty years from now no one will doubt the economy and necessity of the study of unit times and of the planning department.

The following are the leading functions of the planning department:—

A.—The complete analysis of all orders for machines or work taken by the company.

B.—Time study for all work done by hand throughout the works, including that done in settling the work in machines, and all bench, vice work and transportation, etc.

C.—Time study for all operations done by the various machines.

D.—The balance of all materials, raw materials, stores, and finished parts, and the balance of the work ahead for each class of machines and workmen.

E.—The analysis of all inquiries for new work received in the sales department and promises for time of delivery.

F.—The cost of all items manufactured, with complete expense analysis, and complete monthly comparative cost and expense exhibits.

G.—The pay department.

H.—The Mnemonic Symbol System for identification of parts and for charges.

I.—Information bureau.

J.—Standards.

K.—Maintenance of system and plant, and use of the tickler.

L.—Messenger system and post office delivery.

M.—Employment bureau.

N.—The shop disciplinarian.

O.—A mutual accident insurance association.

P.—Rush order department.

Q.—Improvement of system or plant.

A.—The Complete Analysis of All Orders for Machines or Work taken by the Company.

This analysis should indicate the designing and drafting required, the machines or parts to be purchased, and all data needed by the purchasing agent, and as soon as the ne[illegible]

come from the drafting room, the lists of patterns, castings and forgings to be made, together with all instructions for making them, including general and detail drawing, piece number, the Mnemonic Symbol belonging to each piece (as referred to in "H")—a complete analysis of the successive operations to be done on each piece, and the exact route which each piece is to travel from place to place in the works.

B.—*Time Study for All Work Done by Hand throughout the Works, including that Done in Setting the Work in Machines, and all Bench, Vice Work, and Transportation, etc.*

This information for each particular operation should be obtained by summing up the various "unit times" of which it consists. To do this, of course, requires the men performing this function to keep continually posted as to the best methods and appliances to use, and also to frequently consult with and receive advice from the executive gang bosses who carry out this work in the shop, and from the man in the department of standards and maintenance of plant (J) beneath. The actual study of "unit times," of course, forms the greater part of the work of this section of the planning room.

C.—*Time Study for all Operations Done by the Various Machines.*

This information is best obtained from slide rules, one of which is made for each machine tool or class of machine tools throughout the works; one, for instance, for small lathes of the same type, one for planers of same type, etc. These slide rules show the best way to machine each piece, and enable detailed directions to be given the workman as to how many cuts to take, where to start each cut, both for roughing out work and finishing it, the depth of the cut, the best feed and speed, and the exact time required to do each operation.

The information of function "B," together with that of "C," afford the basis for fixing the proper piece rate, differential rate, or the premium to be paid (according to the system employed.)

D.—*The Balance of all Materials, Raw Materials, Stores, and Finished parts, and the Number of Days' Work Ahead for Each Class of Machines and Workmen.*

Returns showing all receipts, as well as the issue of all raw materials, stores, partly finished work, and completed parts and machines, repair parts, etc., daily pass through the balance clerk, and each item of which there have been issues or receipts, or which has been appropriated to the use of a machine about to be manufactured, is daily balanced. Thus the balance clerk can see that the required stocks of materials are kept on hand by notifying at once the purchasing agent or other proper party when the amount on hand falls below the prescribed figure. The balance clerk should also keep a complete running balance of the hours of work ahead for each class of machines and workmen, receiving for this purpose daily from A, B, and C statements of the hours of new work entered, and from the inspectors and daily time cards a statement of the work as it is finished. He should keep the manager and sales department posted through daily or weekly condensed reports as to the number of days of work ahead for each department, and thus enable them to obviate either a congestion or scarcity of work.

E.—*The Analysis of all Inquiries for New Work Received in the Sales Department and Promises for Time of Delivery.*

The man or men in the planning room who performs the duties indicated at "A" above should consult with B and C and obtain from them approximately the time required to do the work inquired for, and from D the days of work ahead for the various machines and departments, and inform the sales department as to the probable time required to do the work and the earliest date of delivery.

F.—*The Cost of all Items Manufactured, with Complete Expense Analysis, and Complete Monthly Comparative Cost and Expense Exhibits.*

The books of the company should be monthly closed and balanced as completely as they usually are at the end of the year, and the exact cost of each article of merchandise finished during the previous month should be entered on a comparative cost sheet. The expense exhibit should also be a comparative sheet. The cost account should be a completely balanced account, not a memorandum account as it generally is; and the entire expenses of the establishment, direct and indirect, including the administration and sales expense, should be charged to the cost of the product which is to be sold.

G.—*The Pay Department.*

The pay department should include not only a record of the time and the wages and piece-work earnings of each man, and his weekly or monthly payment, but the entire supervision of the arrival and departure of the men from the works, and the various checks needed to insure against error or cheating. It is desirable that some one of the "exception systems" of time keeping should be used.

H.—*The Mnemonic Symbol System for Identification of Parts and for Charges.*

Some of the Mnemonic Symbol Systems should be used instead of numbering the parts or orders for identifying the various articles of manufacture, as well as the operations to be performed on each piece, and the various expense charges of the establishment. This becomes a matter of great importance when written directions are sent from the planning room to the men, and the men make their returns in writing. The clerical work and chances of error are thereby greatly diminished.

I.—*Information Bureau.*

The information bureau should include catalogues of drawings (providing the drafting room is close enough to the planning room) as well as all records and reports for the whole establishment. The art of

properly indexing information is by no means a simple one, and as far as possible it should be centred in one man.

J.—Standards.

The adoption and maintenance of standard tools, fixtures and appliances, throughout the works and office, as well as the adoption of standard methods of doing all operations which are repeated, is a matter of importance, so that under similar conditions the same appliances and methods shall be used throughout the plant. This is an absolutely necessary preliminary to success in assigning daily tasks which are fair and which can be carried out with certainty.

K.—Maintenance of System and Plant, and use of the "Tickler."

One of the most important functions of the planning room is that of the maintenance of the entire system, and of standard methods and appliances throughout the establishment, including the planning room itself. An elaborate time table should be made out showing daily the time when and place where each report is due, which is necessary to carry on the work and to maintain the system. It should be the duty of the member of the planning room in charge of this function to find out at each time through the day when reports are due, whether they have been received, and if not, to keep bothering the man who is behind hand until he has done his duty. Almost all of the reports, etc., going in and out of the planning room can be made to pass through the hands of this man. As a mechanical aid to him in performing his function the "tickler" is invaluable. The best type of "tickler" is one which has a portfolio for each day in the year, large enough to insert all reminders and even quite large instruction cards and reports without folding. In maintaining methods and appliances, notices should be placed in the "tickler" in advance, to come out at proper intervals throughout the year for the inspection of each element of the system, and the inspection and overhauling of all standards, as well as the examination and repairs at stated intervals of parts of machines, boilers, engines, belts, etc., likely to wear out or give trouble, thus preventing breakdowns and delays. One "tickler" can be used for the entire works, and is preferable to a number of individual "ticklers"; each man can remind himself of his various small routine duties to be performed either daily or weekly, etc., and which might be otherwise overlooked by sending small reminders, written on slips of paper, to be placed in the "tickler" and returned to him at the proper time. Both the "tickler" and a thoroughly systematised messenger service should be immediately adjacent to this man in the planning room, if not directly under his management.

The proper execution of this function of the planning room will relieve the superintendent of some of the most vexatious and time-consuming of his duties, and at the same time the work will be done more thoroughly and cheaper than if he does it himself. By the adoption of standards and the use of instruction cards for overhauling machinery, etc., and the use of the "tickler" as above described, the writer reduced the repair force of the Midvale Steel Works to one-third its size while he was in the position of master mechanic. (There was no planning department, however, in the works at that time.)

L.—Messenger System and Post Office Delivery.

The messenger system should be thoroughly organised and records kept showing which of the boys are the most efficient. This should afford one of the best opportunities for selecting boys fit to be taught trades, as apprentices or otherwise.

There should be a regular half hourly post office delivery system for collecting and distributing routine reports and records and messages in no especial hurry throughout the works.

M.—Employment Bureau.

The selection of the men who are employed to fill vacancies or new positions should receive the most careful thought and attention, and should be under the supervision of a competent man who will inquire into the experience and especial fitness and character of applicants, and keep constantly revised lists of men suitable for the various positions in the shop. In this section of the planning room an individual record of each of the men in the works can well be kept, showing his punctuality, absence without excuse, violation of shop rules, spoiled work or damage to machines or tools, as well as his skill at various kinds of work; average earnings, and other good qualities, for the use of this department as well as the shop disciplinarian.

N.—The Shop Disciplinarian.

This man may well be closely associated with the employment bureau and, if the works is not too large, the two functions can be performed by the same man. The knowledge of character and of the qualities needed for various positions acquired in disciplining the men should be useful in selecting them for employment. This man should, of course, consult constantly with the various foremen and bosses, both in his function as disciplinarian and in the employment of men.

O.—A Mutual Accident Insurance Association.

A Mutual Accident Insurance Association should be established, to which the company contributes as well as the men. The object of this association is twofold: First, the relief of men who are injured; and, second, an opportunity of returning to the workmen all fines which are imposed upon them in disciplining them, and for damage to company's property or work spoiled.

P.—Rush Order Department.

Hurrying through parts which have been spoiled or have developed defects, and also special repair orders for customers, should receive the attention of one man.

Q.—Improvement of System or Plant.

One man should be especially charged with the work of improvement in the system and in the running of the plant.

As already stated, the planning room gives its orders and instructions to the men mainly in writing, and of necessity must also receive prompt and reliable written returns and reports which shall enable its members to issue orders for the next movement of each piece, lay out the work for each man for the following day, properly post the balance of work and materials accounts, enter the records on cost accounts and also enter the time and pay of each man on the pay sheet. There is no question that all of this information can be given both better and cheaper by the workman direct than through the intermediary of a walking timekeeper, providing the proper instruction and report system has been introduced in the works, with carefully ruled and printed instruction and return cards, and particularly providing a complete Mnemonic system of symbols has been adopted so as to save the workmen the necessity of much writing. The principle to which the writer wishes to call particular attention is that the only way in which workmen can be induced to write out all of this information accurately and promptly is by having each man write his own time while on day work, and pay when on piece work, on the same card on which he is to enter the other desired information, and then refusing to enter his pay on the pay sheet until after all of the required information has been correctly given by him. Under this system, as soon as a workman completes a job and at quitting time, whether the job is completed or not, he writes on a printed time card all of the information needed by the planning room in connection with that job, signs it, and forwards it at once to the planning room. On arriving in the planning room each time card passes through the order of work or route clerk, the balance clerk, the cost clerk, etc., on it way to the pay sheet, and unless the workman has written the desired information the card is sent back to him, and he is apt to correct and return it promptly, so as to have his pay entered up. The principle is clear that if one wishes to have routine clerical work done promptly and correctly it should somehow be attached to the pay card of the man who is to give it. This principle, of course, applies to the information desired from inspectors, gang bosses, and others as well as workmen, and to reports required from various clerks. In the case of reports, a pay coupon can be attached to the report which will be detached and sent to the pay sheet as soon as the report has been found correct.

Before starting to make any radical changes leading toward an improvement in the system of management, it is desirable, and for ultimate success in most cases necessary, that the directors and the important owners of an enterprise shall be made to understand, at least, in a general way, what is involved in the change.

In addition to the directors of the company, all those connected with the management should be given a broad and comprehensive view of the general objects to be attained and the means which will be employed. They should fully realise before starting on their work, and should never lose sight of the fact, that the great object of the new organisation is to bring about the two momentous changes in the men :—

First—A complete revolution in their mental attitude towards their employers and their work ; and

Second—As a result of this change of feeling such an increase in their determination and physical activity, and such an improvement in the conditions under which the work is done as will result in many cases in their turning out from two to three times as much work as they have done in the past.

They must be brought to see that the new system changes their employers from antagonists to friends, who are working as hard as possible side by side with them, all pushing in the same direction, and all helping to bring about such an increase in the output and to so cheapen the cost of production that the men will be paid permanently from thirty to one hundred per cent. more than they have earned in the past, and that there will still be a good profit left over for the company.

PAGE'S MAGAZINE

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OUR MONTHLY SUMMARY.

LONDON, August 20th, 1903.

The Paris Underground Fire.

The terrible calamity on the Paris underground, by which eighty-four passengers were killed, has occurred at a time when London is being literally mined with a network of underground "tubes." It is quite impossible to underrate its significance as a warning to the promoters of electrical railways, for it will leave no excuse whatever to those responsible for tube schemes who may in future neglect to take the precautions which it has so dramatically enforced. It is quite conceivable that the conflagration was rendered much more serious by the driver of the burning train endeavouring to push forward through the tunnel in a hopeless attempt to reach the terminus instead of trying to extinguish the flames in the open, but whether the officials did or did not lose their presence of mind is a secondary matter. The question which comes uppermost for solution is why, seeing that the risk of fire on electric railways is well-known, have the authorities been content to make use of dry, and resinous wood not only for the carriages but for the sleepers and the railway platforms in the stations. Dense volumes of smoke from such material in an underground tube are even more death-dealing than flame, and in the Paris tube did their work with fatal effect.

One or two other points of little less importance than the employment of uninflammable material have also been brought home to the authorities. In a break-down on an electric railway, a failure of the light opens up all the elements of panic, and there can be little doubt that provision should be made for some kind of auxiliary luminant in such an event. Attention has naturally reverted from the Paris railway to our own tubes, present and prospective, and Mr. C. T. Yerkes's prompt assurances must have been welcome to many.

Mr. Yerkes on the Situation.

Says Mr. Yerkes in a letter to the *Times*: "I have on every occasion where I have come before the public concerning this subject expressed my decided opinion that no car should be allowed to run in a tunnel where the said car is made of combustible material. It is simply impossible to equip cars, or anything else, electrically and have them positively free from danger by fire unless the material is non-inflammable. This has been proved repeatedly; and no car should be allowed to go into a tunnel that is not made entirely of non-combustible material.

"I would say that it is a very rare occurrence for a car to be set on fire directly from a motor. Fires occur from a short circuit in the wire connecting the motor with other parts of the train. These wires are run under the body of the car, and where there is anything wrong, like a faulty splice, which is generally the cause of fire, ignition of the woodwork which surrounds the arc must certainly take place. Iron tubing is no protection whatever. If an electric wire be covered with rubber or other non-conducting material, placed in an iron tubing, and a short circuit or arc be formed, by the separation of the wire, the iron tube will be melted, and it will disappear the same as though it was so much paper. Asbestos or its compounds will

be burnt or destroyed wherever exposed to the arc, and I know of no substance that will withstand the heat of an electric arc.

"In my opinion, non-inflammable wood, properly treated—and it can be properly treated in London—is the best material that can be used. Holes can be burnt in it, as they can in iron, but it will not blaze or smoke. We have samples of wood that have been tested, and the result has always been the same. What is most desirable is a car that will not burn; in fact, there should be no portion of it that can create a smoke, for this smoke is more fatal than the flame itself. The flame cannot carry far, but the smoke permeates every crack and crevice.

"Another thing that I believe is most important is a system of ventilation that would force air into the tunnel, and draw the smoke or fœtid air from it. There is not the least difficulty in making our tunnels and tubes perfectly safe, indeed, even more so than those railways whose carriages are running on the surface, from the fact that where there is nothing to burn it is impossible to have a fire; and that is what we must have in the tunnels, not only the cars, but the stations and every particle of wood that goes into them, no matter how small or unimportant, must be so treated that it cannot burn."

International Electrical Congress.

In connection with the Universal Exposition at St. Louis next year, it has been decided to hold an international electrical congress there, the time selected being the second week in September. Thus the fixture will immediately precede the great scientific congress appointed by the Exposition. The international electrical congress will, according to the present plan, comprise three distinct features; namely, a chamber of delegates appointed by governments; the main body of the congress divided into sections; and conventions simultaneously held by various electrical organisations in the United States. The last international electrical congress was held in Paris in 1900. The congress arrangements are in the hands of a committee of organisation consisting of thirty-three members, all active representatives of American electrical progress, and Professor Elihu Thomson has been elected president.

Canadian Railway Enterprise.

While we were going to press last month, Sir W. Laurier introduced a Bill of far-reaching consequences into the Canadian Parliament, providing for the construction of a national trans-continental railway. The scheme combines a partly constructed Government line with a Government guarantee of the bonds to be issued by the Grand Trunk to pay for the rest of the line. The Dominion authorities will build a line to run from Moncton, in the south-eastern part of New Brunswick, near the coast, to Winnipeg, *viâ* Quebec, while the Grand Trunk is to continue the road to the Pacific Coast. The portion of the line between Moncton and Winnipeg, a distance of about 1,700 miles, for which no surveys have yet been made, will, it is expected, pass about a hundred miles north of Montreal and of the Canadian-Pacific line between Montreal and Winnipeg, thus opening up a section of country now practically uninhabited.

Sir W. Laurier explained at some length the reasons which had induced the Government to enter into an agreement with the promoters of the Grand Trunk Pacific, the chief of which were the rapid development of the Canadian North-West and the necessity of Canada being absolutely independent of the United States. Repeatedly had their neighbours threatened abrogation of the bonding privilege, and although Canada was now in friendly relations with the United States, yet one never knew when in a moment of frenzy those relations might be strained. Canada would have commercial independence only when this line was built to the maritime provinces; then she would be perfectly safe. He claimed that the cost to Canada of the new railway would be only $2,000,000 a year for seven years.

The Rise of the Turbine.

Professor Ewing's confident statement as to the future of the steam turbine for marine propulsion, contained in his report on the *Turbinia*, seems likely to be realised in fact. Following the successful performances of the ss. *Queen*, the Belgian Government have decided to introduce a turbine boat for the Dover-Ostend service, while of the four fast steamers lately ordered by the Midland Railway for their Belfast service, two are to be fitted with Parsons' turbines. In the report referred to, the advantages of the turbine were summed up by Professor Ewing as follows:—

It is clear that the substitution of turbines will allow an immense reduction to be effected in the weight and size of marine engines, to obtain the same power; and, further, that this may be done without increasing the consumption of coal. For naval purposes it allows of the crowding into small craft of an amount of engine power such as has hitherto been impracticable with the attainment of correspondingly increased speed.

The general impression I have formed from the trials is entirely favourable to the prospects of this novel method of marine propulsion. The mechanical simplicity of the turbines, and the absence of exposed parts and of working joints will go far to secure them against breakdowns. They have a distinct advantage over ordinary engines in first cost, in probable cost of maintenance, and in cost of attendance, as well as in bulk, in weight, and in freedom from vibration. There appears no reason to doubt that in regular use at sea their running will be as consistently steady and good in every way as it has been throughout these trials.

The application of steam turbines to torpedo-boats, destroyers, gunboats, and cruisers is to be anticipated from their unique capacity for developing great power and high speed with light and compact machinery. Apart, however, from these uses, it appears to me highly probable that they will in time be adopted in the Mercantile Marine. The conditions in a fast passenger steamer are favourable to the economical application of steam turbines, and in such steamers, the smoothness of their running will be a strong recommendation. I see no drawback likely to detract from their advantages which they plainly possess.

The Trade of Natal.

The launching of the new floating dock, built by Messrs C. S. Swan and Hunter to replace the dock which was wrecked during its passage out to Durban, is a matter of more than ordinary importance to Natal, for at present there is no graving dock between Cape Town and Mauritius—a distance of 2,000 miles. After the launch Sir Walter Peace, Agent-General in London for Natal, voiced a happy augury for the future of the colony, which he said, had no chance of improving trade under the Kruger *régime*, as compared with Cape Colony. The Cape Government and the old Pretoria Government were in such close sympathy that the trade went with the sympathy, and

but little development could take place in Natal. Now that the Transvaal was under the British flag, Natal would have a chance. The port of Durban was 200 miles nearer Johannesburg than any other British port, so they might be tolerably sure that the prosperity of Natal would be greater in the future than it had been in the past. The tonnage of steamers and sailing vessels in the port last year was 2,000,000; and it would be quite possible to find work for four or five docks of similar dimensions if they were available. It was mentioned that Natal's imports for the past six months had been £8,000,000, and the exports, £5,500,000—a very large increase over the corresponding period of last year.

The English Charlottenburg.

Despite the fact that the scheme of higher technical education propounded by Lord Rosebery is still in embryo, there have not been wanting criticisms upon its general tenor. For instance, Mr. T. Bailey Saunders points out that if a new technical college is built with the money now available, on four acres at South Kensington, or is maintained even at the start with £20,000 a year, or is restricted to the subjects mentioned, it will be a small affair compared with its great exemplar at Berlin. Mr. Saunders also urges that in spite of the intention which Lord Rosebery mentions, that it should not duplicate or overlap any instruction provided at present; in spite of the proposal that it should work "in close co-operation" with other colleges, it must inevitably, to some extent, enter into competition with them, and to that extent promote a waste of energy. He submits that at the present time in London we should spend only what is absolutely required on bricks and mortar, and as much as possible on men. "It is men, and not buildings that make a University. Improve the positions of professors and other teachers, render them more attractive, put them on a level with similar positions in other careers, and induce the best talent that the country can supply to come to London and to stay there.

Where better laboratories or appliances can be used with advantage, provide them; but, if possible, first improve those that exist. If an institution, or a department of an institution, is already doing good work, and more and better work is needed, help the governing body to meet the demand, and do not make the mistake of setting up another institution with a similar object next door." In conclusion, he asks "Cannot the City and the County Council join hands, and extend and improve the existing institution at South Kensington, together with such departments of King's and University Colleges as provide instruction both in the theory and in the application of science? In this way, at least, a waste of energy would be avoided, pernicious competition would be stayed, and, what would be the most valuable result of all, science itself the mistress of the house, would be encouraged as well as the hand-maid technology."

No doubt, the promoters of the scheme will welcome all the constructive criticism they can get. Mr. Saunders is obviously actuated by a keen desire to see the utmost advantage taken of the munificent gift which has been made to the nation, and his remarks are tendered in a friendly and appreciative spirit, but we doubt if the scheme is yet sufficiently advanced for effective criticism.

Sir Fortescue Flannery, M.P., on British Trade.

On the occasion of the award of certificates at the Crystal Palace School of Engineering, Sir Fortescue Flannery, M.P., was able to speak in an optimistic vein of the future of technical education in this country, though he deplored its neglect in the past. We had, he said, a rude awakening a short while ago by seeing our markets flooded with the productions of other countries, and some of our trades seriously injured by foreign competition, and Englishmen began to look about to see how such a state of things could be remedied. The first and most important step towards that end was obviously to improve the technical education, not only of our artisans, but also of those of the higher grades who would have to direct those artisans. He did not think the injury that had been done to our trade could be exaggerated. In his own daily work, he was sorry to tell them, he had had to sanction, within the last few months, German manufactured plates worked into British-made boilers, and German forgings worked into the shafting of British-built engines. The reason he had to do so was simply this—that, if he had objected to the German-made boiler-plates and shafting, it would have been impossible for the British contractor to have competed successfully with the German contractor for the whole of the work instead of only a part of it. It was a startling fact that the British manufacturer or contractor could not compete with the German and American unless he incorporated German material into the work he had to execute, and it ought to convince everybody of the importance and urgency of thorough technical instruction in our schools. The German method, system of organisation, and technical training were remarkable, and he believed their success was as much due to that as to the superior scientific and technical knowledge in the case of many of their leading managers and engineers. We were now moving in the right direction, however, and he was sure we should overtake the Germans in regard to technical knowledge, but whether we should do so with respect to organisation and method he was not quite so sure. Technical education was now being carried out in the country on the right lines, and we should soon feel the benefit of it.

Technical Education Finances.

A return was recently issued with reference to the application by local authorities of funds to the purposes of technical education under the Local Taxation (Customs and Excise) Act, 1890, and other Acts. This shows that the total amount expended on technical education in England and Wales during the year 1901-2 was £1,057,399. This amount is exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The amount raised by loan on the security of the local rate under the Technical Instruction Acts was £206,426, the amount of loans (so raised) outstanding was £1,030,952, and the balance in hand of moneys received and allocated to technical instruction was £658,319 16s. The total amount of the residue received under the Local Taxation (Customs and Excise) Act by the councils of counties and county boroughs in England (excepting the county of Monmouth) in respect of the financial year 1901-2 was £855,257, of which £817,970 was appropriated to educational purposes, and £37,287 to relief of rates, the latter sum including £16,809 devoted by the London County Council to relief of rates.

NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT,

BY

N. I. D.

IN August those interested in the Navy turned their thoughts naturally to the manœuvres: the trials of men and material on a large scale. It is surprising, when one looks back, that it is less than twenty years ago that naval manœuvres were invented. Prior to that time officers and men, whatever their grades or ratings, were subject to examinations in so far as the routine work of the week was concerned, varied by the exigencies of nature's moods and a sea profession, but were put to no trial or test to ascertain their capacity for actual manœuvring. Ships, too, were tried singly, and now and again there might be a steaming match between a few of them, but anything like the manœuvres such as we are now so familiar with, was quite unknown.

The Naval manœuvres of 1903 will be noteworthy for several reasons. In the first place, the number of vessels engaged was, numerically speaking, larger than anything that has ever been attempted before. There were two independent sets of operations, in one of which only the heavier craft took part, and in these there were no fewer than twenty-six battleships, of which the only two that might be considered otherwise than first class were the *Benbow* and the *Sans Pareil*. Of the *Benbow*, it was noted, however, that out of a fleet of seven ships, she was the only one which kept up the speed of 13 knots in the four days' steaming from Berehaven to a rendezvous near the Azores. The cruisers, numbering forty-three all told, included some of the newest and most powerful vessels of that type in the world. The following table shows the composition of these fleets.—

B FLEET.

Vice-Admiral Sir A. K. Wilson, V.C., K.C.B.

B1 Fleet.

Battleships.	*Cruisers.*	*Battleships.*	*Cruisers.*
Revenge (Flag)	Good Hope (Flag)	Benbow	Venus
Empress of India (Flag)	Drake	Sans Pareil	Melampus
Royal Oak	Sutlej		Latona
Royal Sovereign	Hogue		Apollo
Hood	Edgar		Andromache
	Hawke		Æolus
	Dido		Medea
			Medusa

B2 Fleet.

Battleships.	*Cruisers.*	*Battleships.*	*Cruisers.*
Majestic (Flag)	Europa	Jupiter	Sappho
Magnificent (Flag)	Doris	Hannibal	Prometheus
Mars	Hermes	Prince George	
	Minerva	Repulse	
	Rainbow	Ramillies	

X FLEET.

Admiral Sir Compton Domvile, G.C.V.O., K.C.B.

Battleships.	*Cruisers.*	*Battleships.*	*Cruisers.*
Bulwark (Flag)	Bacchante (Flag)	Illustrious	Vindictive
Venerable (Flag)	King Alfred	Renown	Hermione
London	Aboukir		Naiad
Formidable	Powerful		Intrepid
Implacable	Imperieuse		Iphigenia
Irresistible	Diadem		Spartan
Russell	Spartiate		Scylla
Exmouth	Blake		Pandora
Cæsar	Diana		Pioneer
	Gladiator		Pyramus
			Pegasus

The other series of operations took place independently in the Irish Channel, and engaged in them were no fewer than sixty-one destroyers, thirty-seven torpedo boats, and twenty-seven other vessels. In the two series of operations, therefore, altogether one hundred and ninety-five vessels, apart from certain auxiliary ships for the service of the umpires, were flying the pennant. It will tend to lucidity if I describe the fleet manœuvres first, and then the other operations; although the two must be taken together in making an estimate of the value obtained from these huge undertakings.

The two opposing sides in the operations were known as B and X respectively, X being represented by a powerful fleet concentrated at a single port (Lagos Bay), while B was represented by two fleets known as B1 (Berehaven) and B2 (Madeira), stationed at ports 1,200 miles apart. B1 and B2 fleets were each of them inferior in number and speed to the X fleet. But when combined they were superior in numbers to the X fleet, both as regards battleships and cruisers. The composition of each of these fleets will be seen in the table above. Generally speaking the speed of the B1 battleships might be put at 12½

knots, that of the B2 battleships at 14½, and that of the X at 16½. Many of the cruisers on both sides had an estimated speed of over seventeen knots, and some of them much higher. The position of the three fleets, as has just been described, and the general idea of what was to take place is officially stated in this way :—

"The contest for the command of the sea between two maritime countries B and X has been in progress for some time. In the waters approximately between Gibraltar and Madeira X has been victorious, and B driven with loss into his defended port at Madeira. In Northern waters, however, B has so effectually disposed of the enemy's fleet that he is able to despatch a force (B1) to the South for the purpose of combining with his available forces at Madeira (B2), and then engaging X, known to be concentrating at Lagos."

X occupied, therefore, at the moment when hostilities were to be resumed, an interior position on the flank of the line of communication between B1 and B2, and was at the same time nearer to B2 than to B1. The Admiral in command of X was aware of the date upon which B1 would put to sea, and he knew also when B2 would be ready to leave port, and his own cruisers were free to commence their operations at the same time as his enemy left Berehaven. The Admiral of B, on the other hand, had already furnished his Vice-Admiral in command of B2 fleet with written instruction as to the manner of effecting a junction with him at a given rendezvous, but the nature of these instructions was, of course, a secret to X. In short, the paramount object of the B divisions was to effect a junction, and that of X to use his superior force to destroy one of them before this could be accomplished.

The war began on August 5th, at eight o'clock in the morning, when simultaneously Sir Arthur Wilson, with the B1 fleet, left Berehaven, and Sir Baldwin Walker, with the cruisers of the X fleet, left Lagos in order to watch the enemy (B2) at Madeira. The cruisers of the B2 fleet left Madeira at the same time in order to get in touch as soon as possible with their friends coming from Berehaven. The rendezvous which Sir Arthur Wilson had fixed upon for the two divisions of his fleet to meet was in lat. 39° 15″ N., long. 29° 30″ W., at a point some fifty miles to the north-west of the Island of Fayal in the Azores. This point he hoped to reach at midnight on Saturday, August 8th, B2 fleet having been ordered to leave Madeira at noon on August 6th, and to steam for that point at a speed of fourteen knots. The X cruisers were ordered by Sir Compton Domvile to form a chain disposed from Madeira to a rendezvous two hundred and sixteen miles north of Madeira, and three hundred and sixty-six west of Lagos ; towards this spot fleet X steamed at the rate of fifteen knots when it left Lagos at four o'clock on the morning of August 6th. Early on the following morning intelligence was passed along the chain of cruisers that B2 had left Madeira and was one hundred miles west of that island steering towards the Azores. The X fleet then altered course due west, continuing on a line which would cross the supposed path of B2. The X cruisers kept their Admiral acquainted with the movements of B2 up to the morning of August 8th, the *Bacchante* of the X fleet witnessing the junction of B1 and B2 fleets, seventy-five miles north of Fayal at about 7 p.m. on August 8th. That evening the *Bacchante* was chased by the *Good Hope*, one of the B cruisers, and after an engagement both ships returned to Lagos out of action. It will be noted that the junction of the two fleets took place a little bit further north, and a few hours earlier than was anticipated. At one p.m. on Sunday, the 9th (the following day), the two fleets, X and B, met in lat. 39° 40″ N. and long. 26° 27″ W., and an action took place. At the time of the battle the B fleet consisted of fourteen battleships and fourteen cruisers, the absentee battleship being the *Ramillies*, which had been left behind at Madeira, while the X fleet consisted of ten battleships and four cruisers, the battleship *Exmouth* having broken down and been left behind. Sir Compton Domvile's ships having superior speed, he engaged the leading ships, which happened to be those of the Channel Fleet of the enemy's line, and he claimed to have put four of these, the *Magnificent*, *Prince George*, *Hannibal* and *Mars*, out of action ; he conceded, however that the enemy had, on the other hand, put three of his ships, those in the rear of his line, the *Renown*, *Cæsar*, and *Illustrious*, *hors de combat*.

Assuming that this was the result of the action, it could not be called a victory for B, since Admiral Domvile was left with the seven best ships he had got, whereas Admiral Wilson's remaining ten were of less power and less speed. Quite apart from this point must be considered the value of the operations. The proper purpose of all manœuvres is not victory, but instruction, and this is true, of course, as much of the torpedo operations as of those just described.

Turning to the torpedo operations in the Irish Channel, the opposing fleets were described as the Red and Blue sides. To the Blue side was allotted the Eastern coast of Ireland from Malin Head, on the North, to Brow Head on the South, and in addition Lundy Island in the Bristol Channel, with its adjacent waters within specified limits. The territory of the Red side extended from the Mull of Kintyre on the West coast of Great Britain, down to and including the Scilly Islands. Four impregnable ports were given to the Blues, Carrickfergus, Kingstown, Waterford, and Lundy Island, and one other, Queenstown, which, although fortified, was open to attack. Similarly, the Reds had three impregnable ports, Loch Ryan, Holyhead, and the Scillies, while Milford could be entered by the enemy, although defended by forts and ships. The force given to the Blue side was, for active service, four cruisers, five torpedo gunboats, and thirty-seven destroyers, while the Reds had nine gunboats, twenty-two destroyers, and thirty-seven torpedo boats. Restrictions were, however, placed upon the speed and coal supply of the Red destroyers,

in order that they should be assumed to be torpedo boats. Depot ships were placed in each of the ports to mother the small craft, but these were to take no active part in the war.

The scheme of operations supposed that the Blues were watching the Red ports, and for this purpose every night they sent out three cruisers to patrol the water in the vicinity of these ports; furthermore, as a protection to the cruisers a force of destroyers was also placed opposite each port, but between them and the cruisers. The fourth cruiser remained at anchor at Queenstown, as another bait to the Red torpedo boats. Not only was this scheme a new one, but another novelty was introduced by obliging each side to direct its operations from a single headquarters, the Blues working through the Post Office and Telegraph Department from Kingstown, and the Reds from Holyhead. It was the object of the Red side to torpedo the Blue cruisers, and as these represented a larger cruiser force out of reach, substitutes were found for them every time that they were destroyed; if the Reds succeeded in their action. A number of rules were prescribed to govern the engagements and their results. Every vessel, for instance, except the cruisers, had, for purposes of identification, a secret number or letter displayed prominently in such a position and of such a size that it could be deciphered with the aid of a glass at certain specified distances. If these numbers were deciphered by the other side, whether from the ships or from the shore, it had the effect of putting the vessel bearing it out of action.

As a result of the manœuvres three of the cruisers were put out of action, the watching vessel being torpedoed on two occasions, while on another night the flotillas from a couple of the Red ports combined in an attack upon the cruiser at Queenstown, and succeeded in destroying her. There were, of course, during the week's war, considerable losses on both sides; the Blues, in addition to their three cruisers, lost two gunboats and twenty-one destroyers, while on the other hand the Reds lost four gunboats and twenty-four torpedo boats. The real lessons of the operations, however, were not, as I have already remarked, a question of defeat or victory on either side, but were gained from the experimental work which, by its teaching, elucidated as far as is possible in peace manœuvres the conditions of torpedo craft warfare.

The results of both series must be held to be entirely satisfactory, most instructive, and very valuable.

GREAT BRITAIN.

Two very important announcements referring to the battleship programme of this country were made in the House of Commons during August, when it was stated by the Secretary of the Admiralty that three new battleships would be laid down in April next, one at each of the three chief public establishments. Replying to another question he said: "It is anticipated that the battleships of the 1903-4 programme will be laid down well before the conclusion of the present year." The vessels to be laid down at the public yards will be those of the 1904-5 programme.

The battleship *Montagu* has been placed in commission, and has gone to the Mediterranean Station. It does not now seem likely that any vessels of this class will be sent to the China Station as was originally rumoured, and it is to be hoped that two, if not all three of the others, will follow the *Russell*, *Exmouth* and *Montagu* to the Mediterranean.

The *Montagu* was laid down on November 23rd, 1899, at Devonport. She was sixteen months on the stocks, and another twenty-seven completing, so that in all she has taken forty-three months to build. Her machinery is by Messrs. Laird Brothers, and consists of two sets of four-cylinder inverted triple-expansion engines, actuated by steam from twenty-four Belleville boilers, with economisers, and developing 18,000 h.p.. The grate area is 1,375 square feet and the heating surface 43,260 square feet. The *Albemarle*, which is a sister ship, has just completed her gun trials in the Channel. They were carried out by the experimental staff of the *Excellent*, and gave most satisfactory results.

Turning to armoured cruisers, I note that the Admiralty have issued specifications for the three vessels of the *Duke of Edinburgh* type which are to be built by private firms. Tenders have also been called for for the machinery of the fourth vessel of this year's programme which is to be built at Pembroke. The *Duke of Edinburgh* I have already described, and it is therefore needless to recapitulate the points of this class.

The first cruiser of the *County* class has been commissioned, Captain D. A. Gamble hoisting the pennant on the *Kent* on August 1st. She has been forty one months under construction, but her completion has been delayed by the changes which have had to be made in the size of her propeller blades, to enable her to reach her designed speed of 23 knots.

Another vessel of this class—the *Donegal*—has recently completed her trials, and has gone back to the builders to be completed for sea. On her thirty hours' one-fifth power trial her engines developed 4,674 h.p., giving her a speed of 14·75 knots, the revolutions averaging 88·8. At the three-fourths power trial the figures were 16,333 i.h.p., 22·30 knots, and 136·4 average revolutions. On the eight hours' full power trial at sea she reached a speed of 23,737 knots with 22,154 h.p., this making her the fastest vessel of her class, but not as has been stated the fastest cruiser of the British Navy, this record being held by the *Drake*, with 24·25 knots. The guns and mountings came very successfully through their tests, the torpedo gear being also satisfactory.

The steadiness of the ship during the firing of the large 6-in. guns was commented on, but the gun sights for these pieces were found to be very faulty, and will need to be replaced. The *Lancaster* was also under trial during August, and at the time of

writing the *Cumberland* is ready to leave the contractors' hands for Portsmouth.

The second class cruiser *Encounter*, launched in June of last year is being made ready for commissioning, and should shortly take her place in the Fleet Reserve. The third class cruiser *Topaze* was launched at the yard of Messrs. Laird Brothers on July 23rd. This vessel, the first of four to take the water, is 360 ft. long by 40 ft. beam. Displacing 3,000 tons, she carries twelve 4-in. quick-firing and eight 3-pounder guns, and is designed for 21·75 knots. Her boilers are of the Laird water tube type, those in her sister ship, the *Amethyst*, building at Elswick, being Yarrow. Her engines are the Parsons' steam turbine, and the normal coal capacity is 300 tons.

The four scouts of this year's programme are to be built by Messrs. Vickers, Sons and Maxim, Ltd., Laird Bros., Ltd., Armstrong, Whitworth and Co., and the Fairfield Shipbuilding Company, respectively. They will be the same in all respects as the four vessels now under construction, and special steel of high tensile strength will be used for their hulls.

The destroyers *Blackwater*, *Usk*, and *Cherwell* have been launched by Messrs. Laird Bros., Yarrow and Co., and the Palmer Shipbuilding Company, respectively.

GERMANY.

The past month has been another quiet one in German naval circles, the only event of importance being the launch of the cruiser *Bremen* (ex "L") at the Weser Yards, Bremen. She was the first of a new class of cruisers to take the water, being followed on July 25th by the *Hamburg* (ex "K"), which was on the stocks at the Vulcan Yard, Stettin. There is one other building, known at present as "M," which is to replace the old *Lieben*. These vessels are somewhat similar in design to the *Gazelle* class, but they differ in displacement. They are 361 ft. long and 41 ft. wide, while the draught is 16·4 ft; They displace 3,000 tons, and carry sufficient coal to give them a radius of action of 5,000 miles at half speed. The indicated horse power will be 7,500, giving them a maximum speed of 22 knots. The armament will consist of ten 4·13-in. and twelve 1·45-in. guns, and two 17·7-in. torpedo tubes. Three others of this class are projected, but details as to their building have not yet been made public.

The German Naval Manœuvres this year consist of tactical exercises, scouting and blockade evolutions from August 15th to the end of the month, and strategic manœuvres in the North Sea during the first five days of September. These will conclude with a forced draught run to Kiel, where the ships will recoal, subsequently proceeding to the Baltic for more tactical manœuvres, finishing with a grand attack on Kiel.

RUSSIA.

The *Césarévitch*, battleship, to which I made reference last month, has now left the builders' hands, in charge of a Russian navigating party. As I stated before she succeeded in attaining a speed of 18·25 knots after the alterations to her propeller blades, but later reports from Toulon seem to indicate that she is capable of a better speed than that. Her engines only developed 15,800 h.p., which is 900 less than their full capacity, and when working at full power in her final trials, she made in a twelve hours' run 18·78 knots, and at one time, indeed, was going at over 19 knots.

The new battleship *Slava* is now ready to take the water, and should have been launched before these notes appear. She is sister ship to the *Borodino* and *Orel*, details of which I have already given in these notes.

Two more torpedo-boat destroyers have just been launched—the *Lavidni* and *Lavetni* at the Nicolaieff Steel Works.

It has been stated on very good authority that Russia has now seven submarines completed, and that two submersibles are also just finishing their trials.

UNITED STATES.

A slight disagreement has arisen among the members of the Board of Construction as to the proper design for the new battleships *Idaho* and *Mississippi*, details of which I gave last month. The design was drawn up and submitted to the Secretary for the Navy in the absence of Rear-Admiral K. B. Bradford, who has lodged an objection to the design, since in his opinion 16 knots and 1,750 tons coal capacity is insufficient on a displacement of 13,000 tons. With this opinion I am fain to agree, and those who have followed these notes will remember my belief that when practicable armour and armament should be sacrificed within reason for speed. A comparison between the design of the *Idaho* and the *Césarévitch* will be seen to give some interesting results. The design has been approved by the Secretary for the Navy however.

The battleships *Rhode Island* and *New Jersey*, of the *New Jersey* class, are progressing rapidly, and the *Virginia* is also in a very forward state.

The *Louisiana*, battleship, has progressed much more rapidly than the *Connecticut*, and is nearly four per cent. more advanced than that ship.

In armoured cruisers the *Colorado* is most forward, 57 per cent. of her being completed. Following her are the *West Virginia*, *Maryland* and *Pennsylvania*, all with over fifty per cent. completed, and the *California* and *South Dakota* bring up the rear.

The protected cruisers *Cleveland* and *Denver* are both nearly ready for their trials. The *Des Moines* is 88 per cent. completed, her steel masts have been stepped, and it is anticipated that she will begin her trials early in October. The *Galveston* was launched on July 23rd at the Trigg Ship Yard.

The torpedo-boat destroyer *Macdonough* having been accepted by the Navy Department, there remain only six of these vessels to be finished, and all these are well over 90 per cent. completed.

In the autumn some interesting manœuvres are to be carried out by the United States submarine flotillas. An attack is to be made on Newport by a squadron of battleships, and the submarines are to defend the harbour.

LOCOMOTIVE ENGINEERING NOTES.

BY

CHARLES ROUS-MARTEN.

The "Record" Run to Brighton.

The "record" achieved by the Great Western with the Royal train from London to Exeter, to which reference was made in last month's Notes, was speedily followed by another "record" run—this time on the London, Brighton and South Coast Railway, a line not usually given to record-making or record-breaking. To say this is by no means to disparage the railway or its authorities. "Records" are always, or generally, made only on lines which have the stimulus of competition. Now the London, Brighton and South Coast has an absolute non-competitive monopoly of the traffic between London and Brighton. It has competition to Portsmouth and Hastings, but apparently this traffic is not deemed worth a serious struggle. The competitors, the South-Western in the one case and the South-Eastern and Chatham in the other, have considerably shorter routes, although much more steeply graded, and presumably it is supposed that they could make the better time in the event of a "race to Portsmouth" or a "race to Hastings," were such sporting events conceivable.

Threatened Electric Competition.

But Brighton remains without any alternative service, and its traffic is distinctly a plum worth the picking, or sharing. The fact has often been appreciated by railway company promoters, but hitherto their efforts to float a rival line have invariably been defeated by the astuteness of the diplomacy of the Brighton authorities. This fate has recently befallen, for the second time, a scheme for the connection of London with Brighton by an electric railway which should cover the fifty miles or so in fifty minutes, or less, and do it every hour or half hour. The scheme had several drawbacks, one being a proposed tunnel many miles in length. Now, had the fearful disaster on the Paris underground electric line occurred before the Brighton Bill was before Parliament, there probably would have needed little opposition to ensure its being thrown out. But that fate befell it without so terrible an "example" being required. In these days, however, electric traction is the rage, albeit still in its infancy, and a few casual holocausts in tunnels will not deter promoters from pushing fresh schemes.

A Demonstration.

The possibility of materially abbreviating the London-Brighton transit time was the paramount inducement offered by the promoters of the electric line which Parliament rejected during the recent Session. It occurred to Mr. W. Forbes, the general manager of the existing railway, that it would not be a bad idea to give a little pleasant demonstration of what could be done on the old line with mere steam. And so he determined to run a special train from Victoria to Brighton and back, on Sunday, July 26th, and to perform the journey each way at an average speed of a mile-a-minute or more. A few journalists and engineers—including the present writer—were invited to be traveller-guests, and there was a muster in force.

The Run.

The train was made up entirely of Pullman coaching stock, such as is used on the Sunday sixty minute train which runs only during the autumn, winter and spring months. The total weight behind the tender was approximately 130 tons. The locomotive was No. 70, "Holyrood," one of the newest of Mr. R. J. Billinton's "Sirdar" design, having 6-ft. 9-in. driving and trailing wheels, four-coupled; inside cylinders, 19 in by 26 in.; about 1,700 square feet of heating surface; 180 lb. steam pressure and leading four-wheeled bogie. The weather was unfavourable at the outset, first wet and then fine, with slowly drying—consequent "greasy"—rail. The road from Victoria to Brighton is not a specially hard one, but it sets out plenty of work for the locomotive. Just after starting, a curved bank at 1 in 64 for nearly half a mile has to be faced. Subsequently there is an almost continuous rise through the suburbs until the Merstham tunnel, eighteen miles from London, is reached. The gradients mostly range from 1 in 264 to 1 in 100, and there are several awkward junctions to be "negotiated," as well as places where speed must be reduced over the new widening and extension works. When the main line is reached there remain three banks at 1 in 264 with corresponding descents. Mr. Billinton's handsome engine, however, notwithstanding all the drawbacks just mentioned, took the train from Victoria to Brighton

a distance of fifty miles seventy-five chains—*i.e.*, only five chains short of fifty-one miles—in the unprecedented time of 48 min. 41 sec. from start to stop, and 48 min. 3 sec. from platform to platform. This represents an average rate of 63·4 miles an hour. Speed was well sustained up the rising grades and rose to a very high point down the falling gradients. A special feature of the trip consisted in the attainment of an undoubted maximum of just 90 miles an hour at the foot of the down grade at 1 in 264 past Hayward's Heath. This was registered independently by *three* separate observers—one with an automatic speed recorder. It adds another to the relatively few authentic instances of such a high velocity having been reached. The return run was done in 50 min. 21 sec. platform to platform, 49 min. 12 sec. start to stop. The longer time was attributable partly to a strong side wind which had arisen since the morning, and partly to some necessary permanent way checks. But it far eclipsed all previous performances from Brighton to London. The results of the trip left little doubt in the minds of the engineers present that the journey could be made either way in forty-five minutes should this be desirable, and by steam traction.

Large Vehicles and Locomotive Power.

It is interesting to learn that the experiment of employing large bogie wagons for long-distance mineral traffic has proved a success on the Caledonian Railway, and that the already-considerable number of such wagons possessed by that railway is being largely augmented. When 30-ton or even 50-ton wagons can be fully loaded and run for long distances without partial unloading, they unquestionably offer many advantages. The proportion of dead weight to paying load is manifestly smaller, and that is always a most desirable thing to be secured. Also their haulage is easier relatively to the load carried than that of smaller vehicles with rigid wheel-bases. The sole drawback attaching to their general use in Britain is that the condition of a full load between terminal points is an essential one as to profit. It has long been a grievance with railway companies that they often have to run a 10-ton truck with only two tons of paying freight in it. Where goods have to be carried from numerous consignors to numerous consignees along lines studded every two or three miles with stations or sidings, at which the often-underloaded wagons have to be detached and left, or picked up singly, it is obvious that wagons carrying twenty or thirty tons or more would be the reverse of helpful. The case, in short, is one of those so frequent in railway experience, which are necessarily conditioned by the circumstances of each.

Large Passenger Coaches.

The huge passenger coaches now mostly constructed for the leading main lines are not open to exactly the same objection as the large freight trucks, but still they are subject to a drawback of their own. So long as they can be employed on long-distance expresses, they are the most convenient and comfortable, while much less hard to haul than far lighter non-bogie stock, although it must be frankly admitted that their dead-weight proportionately to paying load is excessive. But whereas the smaller and cheaper vehicles can be relegated to branch service when no longer suited to main line duty, this can scarcely be done with the enormous twelve-wheelers, weighing from 35 tons to 41¾ tons apiece. Such vehicles could only be used after refitting each one as a composite train in itself, and these might be troublesome to deal with at small branch stations.

Branch Services.

The Great Western has followed the example of the London and South-Western and the London, Brighton and South Coast in the employment of steam motor cars for some branch services, the excellent pattern devised and built at Nine Elms by Mr. Dugald Drummond for the two latter lines having been adopted after due trial. This should result in a material saving in the working expenses of their branch lines, which often are seriously in excess of the trifling receipts. And the Great Western is going to extend the usefulness of these new cars by stopping them where required at level crossings to pick up and set down passengers. This is a very skilful counter-move to the threatened competition of road-motors, and perhaps of tramways also. The North-Eastern led the way in the use of motor-cars on railways, but with another description of motor. The principle, however, is the same, and it seems a very sound one. Certainly there should be no difficulty in working unremunerative though necessary branches much more cheaply than when all the costly paraphernalia of separate engines and coaches are used with their unavoidably larger staffs.

British Manufacturers Awake.

It is very gratifying to read the following statement which has been widely circulated :—

"The Caledonian Railway Company, who were amongst the first in Britain to experiment with the 'high-capacity' wagons in the working of freight traffic, some time ago divided an initial order for fifty 30-ton steel wagons between British and American builders, giving to the Leeds Forge Company the contract for thirty, whilst the construction of the remaining twenty was entrusted to a well-known American firm. The railway authorities, it is of interest to note, merely restricted the builders to their standard draw gear and side buffers, as both firms were expected to build wagons of their own design and tare weight, but to the railway company's gauge limits, and to the satisfaction of the locomotive superintendent of the Caledonian Railway. In short, the placing of these contracts was simply a practical test between British and American design and workmanship. Despite an urgent order for wagons in South Africa, the British firm completed their order well within contract time, the whole of their wagons being working on the Caledonian line some time before the first consignment of six wagons was shipped from America. This is of especial interest, in view of the recent criticism which has been levelled at the heads of British engineers, in which it is claimed that if Great Britain is to 'hold her own' in the markets of the world, she must bring her establishments and working methods more up-to-date. As a result of the experiment the railway company decided not to accept the American wagons. The working of the 30-ton wagons on the Caledonian Railway was found to be so successful that the same company some few months ago placed contracts—but exclusively with British builders—for no fewer than three hundred additional wagons of the 30-ton carrying capacity, and it is of importance to note that the Leeds Forge Company, who secured the contract for the erection of one hundred of the wagons, have completed, and delivered a few days ago, the whole of their order, which left Leeds for Glasgow in four trains of twenty-five wagons each, or an aggregate carrying power of 750 tons each within a period of three months from the date of the receipt of final instructions as to details from the Caledonian Railway."

These enterprising and progressive British builders deserve all possible credit and recognition.

WORKSHOP PRACTICE

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

HIGH SPEED STEELS.

THE discussion on high speed steels at the Leeds meeting of the Institution of Mechanical Engineers revealed great differences of opinion respecting these. In fact, the open discussions that follow the reading of papers at the meetings are generally of more value than the papers themselves, by reason of the divergent opinions that are elicited. But, notwithstanding the remarks of the objectors, of whom Mr. Barrow was the most pronounced, there is no mistaking the general opinion, namely, that there is at the lowest, a clear gain of at least fifty per cent. achieved by the use of these steels, when brought to the test either of time, or of piece-work prices.

The point to remember, however, is that the new steels have their limitations. They show the best records when turning mild steel, for which they are eminently adapted. There is much less advantage in turning cast iron, less in the planing machine than in the lathe, while on finishing cuts they have little superiority over the carbon tool steels. We did not hear of any speeds so high as those of 170 ft. per minute, instanced by Mr. Norris as the maximum desirable in our last month's " Résumé " ; but members in conversation mentioned speeds of 100 ft. to 120 ft.

Mr. Barrow provoked roars of laughter when he designated the new high speed lathes as " hydrocephalous, or big-head lathes, having large heads on bodies of ordinary patterns." But several members testified to the uselessness of the old types for taking the heavy cuts possible by the new steels. Then, again, objection was made to the extra cost for power involved in driving the high speed lathes. Both of these objections are short-sighted, because, when it becomes a question of doubling, trebling, or quadrupling output it is clear that far-sighted economy lies in doing so, at the sacrifice of the old lathes. And, moreover, if one man can do the work of two or three by using the high speed steels, the cost of the new type of lathes, and of the extra power required, is at once discounted.

With regard to the amounts that can be removed, Mr. Ellis mentioned that with a 36-in. lathe, using high speed steels, he was removing 3 tons of shavings every twelve hours ! Mr. Suplee stated that at the Bethlehem Works the high speed steel was introduced in order to enable the company to fulfil a certain contract in a short period, and that it was started at the same time as the premium system there. Mr. Windsor Richards spoke of the " astonishing cuts " he had seen taken at those works. The case of the Canadian Pacific shops was also instanced, where, since the introduction of these steels, the fitters have had to work overtime to keep up with the machinists. This, too, in the face of Mr. Barrow's expressed opinion that the high speed steel came in where a small amount of metal only has to be removed !

But high speed steels will remove small amounts at a more rapid speed and feed than the common tools, because heating is fatal to the latter, while the high speed tools thrive on heat—cutting best when they smoke. This, in fact, is made the test of their efficient action at the Bethlehem Works. In spite of the objectors, we came away from the discussion confirmed in the opinion expressed by the President, that " the subject of the new steels was the most important that had arisen in the machine tool industry in his time."

OLD SHOPS REMODELLED.

In visiting the Leeds shops, one sees the new and the old in very strong contrast. The old shops are being rapidly remodelled, and extended around the old sites. But some firms are terribly handicapped in the old environments, surrounded only with workmen's cottages, blocks of which have to be pulled down as often as extensions are necessary. These extensions do not permit of a well-laid out plan of works, since many of the shops have no proper means of intercommunication, and no economical arrangements for forwarding the work, either through departments, or in connection with lines of railway or canals. Storied buildings, and ground floor buildings alternate, and timber roofs preponderate.

But with regard to internal arrangements, many of these shops are well to the fore. They are equipped now to a considerable extent with modern machines, and electricity is making rapid headway, both for driving machine tools and overhead cranes, and for lighting. In one of the Greenwood and Batley shops, motor driven, the absence of shafts and belts imparted to the building a light and airy appearance, in pleasing contrast with the old class of shops. These works, by the way, are one of the most interesting in or around Leeds, as they afford an admirable illustration of a number of different industries carried on by a rigid sub-division of shops. Except for the central control, it is a congeries of separate works, the strongest contrasts in which are, perhaps, afforded by the work of the turbine department, and that of the cartridge case manufacture. The latter is fitted with automatic and semi-automatic machinery, attended almost entirely by girls ; the former is a department in which some beautiful examples of high class machining and fitting are seen. The Whitehead fish torpedo

department, again, is of about equal interest with the turbine shops. The beautiful hand-fitting in some of the details here, done to templet and gauge, as fine as clockwork, all to be ultimately blown to pieces and lost, is a sight not to be forgotten. The electrical department is a large one. But here one is impressed by the fact that all electrical details are cut and dried, much of the tedious wiring and insulation being so perfectly mechanical that lads are entrusted with its performance.

SOME SPECIAL MACHINE TOOLS.

The machine shop at Green's Economiser Works was highly interesting on account of the many special machine tools that are installed there. There is no such thing as fooling with single cuts when more can be taken at once. Thus, in turning the economiser pipes, the finishing tool follows the roughing, at the same time that the rough ends are being parted off with another tool. And this goes on at both ends simultaneously, while a row of such machines handles a large number of pipes at once. So in planing flanges, special machines are rigged up with a number of tool boxes, all in operation at one time.

HEAVY DIE FORGING.

The Heslop Seamless Steel Boat Works afforded an illustration of die forging or pressing on an immense scale. It is not found practicable to press a boat from one sheet of steel, due to the puckering of the sheet, so all boats are pressed in halves, and afterwards jointed along the keel. There is an advantage, however, in this, namely, that it permits of the insertion of a stiff keel of I section, bent to the required curves, to which the thin flanged edges of the halves are rivetted. With the exception of this, all the boat fittings are of timber. The advantage of the steel hull is that it does not shrink as timber does, in hot climates, and that a smart blow will only bruise, without fracture occurring. The firm turns out some three hundred boats a year, their customers including some of the great steamship companies. The dies used are so massive that they are built up and bolted together in sections. The cost of the entire stock of dies for boats, of different sizes, up to 35 ft. and 40 ft. in length, must have been enormous. The dies are arranged in line with the heating furnace, out of which the sheet to be pressed (of $\frac{1}{8}$ in. steel) is drawn, to be cottared rapidly in place on one edge of the lower die, by men stationed in a row. The lower die is then lifted hydraulically, and the sheet pressed to shape at once.

CRADOCK WIRE ROPES.

The Cradock steel rope works at Wakefield seemed to the writer a perfect maze of stranding machines forming and coiling ropes of all sizes in a purely mechanical fashion. Preliminary to this there is the steel-making works, for the firm manufactures its own steel from Swedish and Cumberland pig. One wonders what becomes of all the ropes made, when a single firm manufactures and stores so large a quantity.

BOX-MAKING MACHINERY.

To the goodly party of engineers who visited York, the box-making department of Messrs. Rowntrees was a fascinating sight. Particularly striking was the planing machine that whisked off a broad shaving of the full width of the board, and of its full length in an instant, and the nailing machines that fastened the corners of the boxes as rapidly as the attendant could present them to the machine.

FARNLEY IRON.

Farnley is a classic name to old engineers, to whom Yorkshire iron was a thing to conjure with. To-day, one sees the same processes carried on there, as in fifty years past. Said the genial Mr. Mathieson to his visitors: "We never mention steel here, it is a new product that has not come this way." And we saw the casting from the blast-furnace into the pig beds, the puddling by hand, the hammering down of the spongy viscous bloom, and the various reheatings and rollings. And, side by side with these old processes, there was the immense new Mond gas plant, driving two 250 h.p. engines, the plant for the recovery of sulphate of ammonia, which returns a big profit, and the up-to-date switchboard, the whole set in the rugged Yorkshire hills surrounding.

SNAP FLASKS.

Those who are interested in foundry work saw a good deal in that line at Green's Economiser works. As the firm handles but one speciality, it has been able to effect great economies in manufacture, and the foundry, like the machine shop just now instanced, is a very big department. This firm has thrown out moulding machines, and substituted hand ramming in snap flasks in their place. We saw a man ramming these, the flasks being about 18 in. square, and were told he would put up about eighty such moulds before breakfast. He was not a skilled moulder either, but would, nevertheless, take away a couple of pounds weekly in wages.

Snap flasks are as yet used to a limited extent in English foundries, and many moulders have never seen one. We may therefore be pardoned for pointing out their special advantage over the ordinary rigid flasks. The snap flask is hinged at one corner, and fitted with a latch at the corner opposite. When in use, the flask is closed by the latch, or sometimes by two latches, in large ones. The mould is rammed, and then the flask is detached from the mould by loosening the latch, and opening the hinge. The flask is removed and the naked mould deposited on the ground for pouring. The advantages are that one flask does duty for any number of moulds, so effecting a big saving in stock flasks, and in storage room for them, that there is no need of bars, stays, or lifters, and that the moulds are light to handle.

But, of course, the snap flask has its limitations, being unsuitable for any moulds but those of small size and of little depth, the limits of utility being about 2 ft. square by 4 in. to 6 in. deep. But these limits include a vast deal of small work, and here the snap flasks may be expected to displace the others in the course of time. They are employed largely, too, in connection with some moulding machines, while the practice of using naked moulds has been long adopted at the Singer factory, at Kilbowie, and others, and in Germany, in connection with certain types of moulding machine. In these, however, the snap flask is not used, but the mould is pushed out of a tapered frame within which it has been rammed. The sand is held together by a ring, or a band of steel.

In the Economiser works the iron is graded by analysis, the mixture for the day being stated in front of the cupola. The excellent quality of the metal used was demonstrated by testing an economiser pipe to destruction before the visitors. It burst at about 3,500 lb.

The above remarks record only a few of the impressions gathered in and about Leeds during the meeting of the Mechanical Engineers. Limitations of space prevent further remarks.

SHIPBUILDING NEWS.

British Shipping Progress.

Some further shipping statistics may now be placed on record in these pages. The total shipping of the world, according to Lloyd's, consists of 29,943 steamers and sailing vessels, representing a tonnage of 33,643,131 tons. This colossal fleet is divided as follows :—

	Number.	Tonnage
Steamers	17,761	27,183,365
Sailing vessels.. ..	12,182	6,459,766
Total	29,943	33,643,131

These figures show an increase over last year of 315 vessels and of 204,368 tons, and the advance is entirely in steamers. There were fewer sailing vessels built in 1902 than in any previous period in the history of the industry, and a large decrease took place in the number and tonnage of those on the registers of the various countries, viz., 290 vessels and 118,000 tons. Of the total tonnage, 33,643,131, nearly one-half is owned in the United Kingdom and our Colonies. A year ago this country had close on fifteen millions and a half of shipping tonnage, but now its tonnage exceeds sixteen millions, and upwards of fourteen millions of that tonnage is composed of steamers. The rest of the nations combined have more than twice as much sailing tonnage as we have, but their steam tonnage falls short of ours by more than a million tons.

The details applicable to each country possessing over, or close upon, 100,000 tons of shipping, in the order of precedence are :—

Flag.	Tonnage.
1. British	16,006,374
2. American	3,611,950
3. German	3,283,247
4. Norwegian	1,653,740
5. French	1,622,016
6. Italian	1,180,335
7. Russian	809,648
8. Spanish	764,447
9. Japanese	726,818
10. Swedish	721,116
11. Dutch	658,845
12. Danish	581,247
13. Austro-Hungarian	578,697
14. Greek	378,199
15. Belgian	157,047
16. Brazilian	155,086
17. Turkish	154,494
18. Chilian	103,758
19. Portuguese	101,304
20. Argentine	95,780

The Chinese come next with 60,000 tons, and the other smaller Powers are much below these figures. All the countries named have increased their shipping tonnage during last year. The British advance is about half a million tons. America, Germany and France have followed to a smaller extent, but the whole of the combined increase amongst all the Powers outside of our own is very little over three quarters of a million.

Multiplication of Huge Steamers.

Next as to the size of steamers belonging to the various nations of the world. A few years ago the number of great merchant vessels of 10,000 tons and over was barely half a dozen, but recently these huge steamers have multiplied to a large extent. Twelve months ago they came to seventy-one, and now they are eighty-seven. Half of them are registered in the United Kingdom, but Germany has upwards of twenty. The following table shows the boats over 5,000 tons.

Flag.	Over 5,000 tons.	Over 7,000 tons.	Over 1,000 tons.
British	366	119	48
German	59	15	26
American.. ..	34	7	7
French	30	4	2
Dutch	6	1	4
Russian	10	2	—
Austro-Hungarian	4	1	—
Japanese	16	—	—
Spanish	7	—	—
Danish	—	1	2

As regards speed, the fastest belongs to Germany, but that position will be reversed as soon as the new Cunarders make their appearance on the ocean. There are now a far larger number of vessels in the British than in any other mercantile marine capable of steaming at a rate of from 15 to 20 knots.

Lloyd's Register.

There are classed in the Register Book of Lloyd's 9,698 vessels, representing a tonnage of 17,443,138. Existing vessels formerly classed number 4,044, with a tonnage of 3,932,026—in all 13,742 vessels, with the enormous tonnage of 21,375,164. Taking the number of vessels alone the comparison with other societies is as follows :—

Society.	No. of Vessels Classed.
Lloyd's Register	9,698
British Corporation	498
Bureau Veritas	5,070
Germanischer Lloyd	2,138
Nederlandsche Vereeniging ..	80
Norske Veritas	1,903
Record of American and Foreign shipping	1,254
Registro Italiano	1,045
Veritas Austro-Ungarico	1,076

These figures mark advances on the part of Lloyd's Register, the British Corporation, and the Germanischer Lloyd, but the other societies seem to have gone back. The vessels classed by Lloyd's Register during 1902 came to 621, with a tonnage of 1,347,764. The greater part of these—544 vessels 1,135,471 tons—were built in the United Kingdom, but several were constructed on the Continent and some in the United States of America.

American Shipbuilding.

Information about shipbuilding in America is always interesting. During the fiscal year ended June 30th, 1,535 vessels of 456,076 gross tons were built in the United States and officially numbered, compared with 1,657 vessels of 473,981 gross tons in the previous fiscal year. Returns of vessels under construction on July 1st, 1903, in the United States indicate for the new fiscal year an output below that of last year. The world's shipbuilding reached its highest point in 1901. The principal decrease in the United States for the past year has been in steel steamers built on the Great Lakes, which numbered 41 of 131,660 tons, compared with 52 of 161,797 tons in the fiscal year 1901–2. The only item of considerable increase has been in unrigged canal boats, barges, etc., numbering 320 of 79,574 tons, compared with 297 of 57,502 tons for the previous year. Nearly two-thirds of the year's output consists of 92 vessels of over 1,000 tons each, aggregating 295,548 gross tons. Of these the Great Lakes' yards built 37 steel steamers aggregating 130,283 gross tons, four of which, aggregating 7,147 tons, are built to pass through the Welland Canal for ocean coasting service. Three lake steamers — *James H. Reed*, *D. G. Kerr*, and *D. M. Clemson*—each slightly exceed 5,500 tons.

On the seaboard eighteen ocean steel steamers of 101,471 gross tons were built, the largest output of this type in the history of the industry in America. The large vessels of this type contracted for in 1900 are now completed, or will be completed, barring strikes or unforeseen delays, before the end of the year. No new contracts for this type have been made for two years. The year's additions were the *Finland*, of 12,760 tons—the largest vessel built in the United States this year—and the *Mississippi*, *Maine* and *Massachusetts*, each of 7,913 tons, all four for the International Mercantile Marine Company; the *Siberia*, 11,284 tons, for the Hawaiian-Asiatic trade of the Pacific Mail; and the *Arizonian* and *Texan*, over 8,600 tons each, for the American-Hawaiian Company. Other steamers are for the coasting trade, of which four steamers of 12,974 tons, carrying oil in bulk, are noteworthy. Two barquentines for the Pacific trade, aggregating 2,638 tons, were the additions to the square-rigged fleet. New wooden schooners over 1,000 tons numbered twenty-one, aggregating 36,537 tons. The steel schooner *Thomas W. Lawson*, of 5,218 tons, was documented early in the year. Other new vessels over 1,000 tons are three wooden steamers aggregating 4,605 tons, three ferry and river steel steamboats aggregating 3,849 tons, and seven rigged barges of 10,947 tons.

The Outlook.

There is, at the time of our writing, no improvement in the shipbuilding industry in this country, and the prospects for the autumn and winter are very discouraging. Moreover, the wages question has again come up for discussion—first, with the marine engineers and next with the shipyard workers—on the termination of the working agreements which expired on the first of August. The evidences of depression in the industry are plain enough, but some of the workmen will not recognise them, declaring that there is plenty of demand for their particular kind of labour in other branches of employment. This may be so, but it does not help shipbuilders nor tend to cheapen shipbuilding.

Huge Liner for the Cape.

During the month there was launched at Govan, from the yard of the Fairfield Shipbuilding and Engineering Company, Ltd., the twin-screw steamship *Armadale Castle*, the latest and largest addition to the fleet of the Union Castle Mail Steamship Company. The vessel, which is intended for the South African Royal Mail Service, is of 12,800 tons capacity, and is fitted with every modern appliance to secure safety, speed, and comfort. Her dimensions are: Length, 590 ft. 9 in.; breadth, 64 ft. 6 in.; depth, 42 ft. 6 in.; and she has 12,500 h.p.

Floating Dock for Durban.

The new floating graving dock launched at Wallsend by Messrs. Swan, Hunter and Wigham Richardson, Ltd., and intended for Durban, is of the same type as that which was built for Bermuda, and is also similar to the one which came to such an unfortunate end while on the way to Durban last year. It is 475 ft. long, 96 ft. 2 in. wide, and has a lifting power of 8,500 tons. The distance between the guard timbers on the side walls is 70 ft., so that the dock can accommodate vessels up to 68 ft. beam, and whilst still retaining a freeboard of 4 ft. 3 in., it can take a vessel drawing 23 ft. over keel blocks 4 ft. high. The dock is divided into forty-four watertight compartments, and is fitted with a complete electric installation for night work and for the use of electric drills, etc.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT.

Paris Metropolitan Electric Railway.

The fearful catastrophe on the Paris Metropolitan Electric Railway has directed public attention to some of the engineering details of underground lines, and in order to reassure the British public, letters have appeared from Mr. Yerkes and others, stating that the rolling stock on the English lines is being made fireproof. In order to provide a comfortable carriage, a certain amount of woodwork is necessary, and it is therefore interesting to note that on certain of the underground railways now being equipped, all such woodwork is being specially treated to make it non-inflammable.

In connection with the Paris disaster, a recent article in *Industrie Electrique,* written before the disaster occurred, has special significance, because in it various faults of the Paris Metropolitan line are very frankly pointed out. It appears that the Municipal Council wished the line to be built narrow gauge, and it was only on the Government interfering that the engineers got their own way, and the normal gauge was adopted. A concession was, however, made as to the size of the tunnel, which, it now turns out, is far too small. In fact, owing to the seating capacity of the trains being cut down, the regulation as to *standing* passengers has fallen in abeyance. This overcrowding, combined with the variable distances between stations, affects seriously the regulation of the traffic, and the building of the line in sections, also causes much changing and waiting about on platforms. The many severe curves also cuts down the average train speed to about twelve miles an hour, and, as it is impossible to increase the size of the carriages or the length of the train, (the dimensions of the tunnel and platform being fixed quantities), the only way to augment the service will be to smooth out the worst of the curves and increase the power of the motors, so as to get more trains through per hour. It is said that the best lessons are learnt from failures, and if the lessons at Liverpool and Paris are thoroughly digested, these disasters will not have been without their benefit to the increasing number of people who travel by underground lines.

Technical Education.

One point in connection with the constantly recurring discussion on the technical training of engineers is the question whether it is worth while a student spending any of his college course in doing workshop work. In the discussion at the recent Civil Engineers' Conference, the consensus of opinion appeared to be that the student should learn only the practical work in *real* workshops, and much was said on the so-called sandwich system. In this system, the student spends some months or a year at college, and then has the same length of time in works, afterwards going back to college, and so on, the whole course covering four years.

In the writer's opinion there is much to be said for this. Some of our smartest young electrical engineers are from Scotland, where the system has been in vogue for years. On the other hand, the writer knows of impossible young men who learnt all their so-called practical work in technical schools. Independently of their lack of technical knowledge, these latter lacked that broad knowledge of affairs and of the world which any intelligent youngster may so readily absorb when knocking about amongst the workmen of an up-to-date factory.

In this connection, it is interesting to note that at the recent meeting of the Canadian Electrical Association there was a paper on the education of the electrical engineer by Mr. Paul Lincoln, of Pittsburg, and it was brought out in the discussion that American colleges do not now attempt to teach practical work, but devote all their energies to training the graduates in a thorough knowledge of *principles.* By the way, Mr. J. G. White, of New York, has also been reading a paper on the same subject at the twentieth annual Convention of the American Institute of Electrical Engineers at Niagara, and he places correct speech and good manners amongst the essential requirements of all budding engineers. It is to be hoped his audience took the advice to heart ; the "very much accented cocksure, we know everything you bet" manner of some of our American friends when they come to this benighted country is—well, it is not manners, anyway.

Supply of Raw Materials.

It is an extraordinary thing, but none the less true, that electrical manufacturers have a difficulty in obtaining supplies of certain materials in either sufficient quantity or of sufficiently good quality. The materials of which the writer has heard complaints, are copper of all kinds—bare wire, strip, and commutator bars ; and cotton-covered wire ; mild steel bars for spindles, also malleable iron, marble asbestos, and porcelains. Copper wire ordered of No. 13 S.W.G. will be right at the beginning of the consignment, and gradually increase in size to nearly No. 12 gauge at the other. If ordered double cotton-covered, it is delivered with

the copper showing through the cotton covering, whilst copper strip is well nigh hopeless on account of its variation in hardness and deviation from exact size. One would have thought that steel bars and malleable iron could have been obtained in any quantity, and yet orders are constantly being sent abroad for these supplies. Perhaps, in the case of asbestos and marble there is some excuse, but why should porcelains be obtained from the States, and yet they are, simply on account of the quality of the English porcelains not being up to standard as to insulation.

In these days, when *quick delivery* counts for so much, no manufacturer, however prejudiced, is going to order materials such as the above from abroad, if he can obtain what he wants near at hand. There is no getting away from the fact that the British electrical manufacturers have been and are even now handicapped by the suppliers of raw materials. Look at the abominable steel castings which were supplied until within quite recent times—scabby castings, no two alike in magnetic quality and delivery, often months after the order was placed.

Then, again, commutator copper. Who has not noticed the halo of copper dust deposited round about dynamo machines? One cannot altogether blame the manufacturer for using soft copper segments when one of the most reputable copper firms in the country have supplied such segments to a specification calling for *hard drawn*. To put it vulgarly, there is need for the suppliers of raw material to "buck up." Plenty of orders are to be had if they will but supply good materials and promptly.

Building Large Commutators.

Commutator construction is an art, especially so in the larger sizes of 3 ft. to 10 ft. diameter, and so on. Not only must the hardness of the copper and mica be graded to an exact nicety to ensure their wearing down together, but the mechanical details call for much careful design, or some of the bars will become dented below the surface, and others ride proud. When the commutator bars are of considerable length, special precautions must be taken to prevent them buckling outwards from centrifugal force, and the way of doing this is to corrugate the segments so that they fit into each other. After the segments and mica have been assembled, it is necessary to drive off the moisture either by stoving or else by arranging a number of bunsen burners to play on to the metal. The writer recently saw a commutator 10 ft. diameter being dried in this way, it was laid on its side, and the bunsen burners were pitched about 18 in. apart.

The last and most important operation is the compressing inwards of the segments and mica preparatory to matching the grooves for the steel end rings. In small commutators this compression is effected by clamps and screws, but in large commutators it has to be effected by means of a Wyld's hydraulic wheel-tyre press.

Regarding the connections to the armature conductors, the modern tendency is to do away with the soldering iron. When the armature conductor is of small enough section, it is bent inwards and slipped into a hole in the commutator, otherwise a short piece of flexible cable $\frac{1}{8}$-in. or $\frac{1}{4}$-in. diameter, is carried down from the end of the conductor. The actual electrical contact with the segment is effected by several small $\frac{1}{4}$-in. or $\frac{3}{8}$-in. diameter steel grub screws.

The British Westinghouse Works.

The writer had recently the pleasure of paying a second visit to the British Westinghouse Works, at Trafford Park. The place is now in full swing, and, in fact, extensions are in hand. The cast iron foundry, which it was prophesied would not be filled for years, is already after only ten months' work, too small for the 500 men occupied in it, and a large amount of casting is being done by outside firms.

Some of the figures connected with these works are astonishing, thus, over 5,000 men are employed, the number having nearly doubled in six months. The staff numbers over 500, and to find employment for this army there is well on for three million pounds worth of work on the books. Amongst contracts in hand, are five steam turbine generators of 3,500 h.p. each for the Metropolitan Railway, and eight of 5,500 h.p. each for the District Railway, the speed being 750 revolutions per minute, and periodicity 33 per second. These turbines are on a new principle, combining the De Laval for the high pressure, and the Parsons for the intermediate and low pressure. It was originally intended to build them of the Parsons type throughout, but the change has been made as the result of some important tests carried out at Pittsburg. End thrust is done away with by bringing the steam in at the centre, and expanding it outwards through the parallel flow turbines as Parsons did in his original machines, made by Clarke, Chapman and Co. There was not much to be seen of the gas engines, but it is interesting to note that amongst those recently completed are two for His Majesty the King, at Sandringham.

AMERICAN RÉSUMÉ.

NEW YORK, August 20th, 1903.

Iron and Steel.

The strike of the union coal miners in Alabama has occasioned considerable apprehension among those responsible for foundry interests. The stock of raw material and pig iron was small, and it was expected that the price would go up very rapidly, especially since the consumers for some time previously had been buying only enough for their approximate needs. It seemed likely that if the strike lasted it must precipitate a buying movement. Up to the time of writing however, with the strike still unsettled, these predictions have proved in error, for buying is still in small lots only, and the price of pig iron continues to recede. Some business has even been done on the basis of $12.00 for No. 2 foundry iron at Birmingham, Ala., and northern foundry has sold down to $16.50 at tide water.

A short time ago there was a rumour to the effect that a western Harvester concern was about to place an order for 23,000 tons of foreign foundry iron. However, this has not yet materialised, in spite of the fact that 99 per cent. of the $4.00 import duty is refunded when the finished machines are exported, because the domestic producers have offered better figures. This is significant, since it shows that foreign pig is not only out of the market for home consumption, but for export goods as well.

The foreign outlook in the steel rail business is better. European mills have been asked to figure on some large lots for Gulf and Pacific coast delivery, and it is quite possible that they will secure some of the orders. At last accounts foreign steel was being offered at $27, and even a trifle under. For large transactions within reach of tidewater this is well under the figures of the home syndicate.

In the Canadian wire rod trade, where the English mills are trying to secure a footing since the abandonment of that field by the Germans to the Americans, the prices have been as low as £5 17s. 6d. at Montreal, which is under the price of the United States mills.

Some good steel bar orders are reported in sight, but that trade generally is weak in the Central West and East, and the sheet trade also is dull. The plate mills are fairly well employed, and anticipate an improvement for the balance of the year. The tin plate mills have continued very busy throughout the month, and the merchant pipe industry is also active, but probably the best prospect of all is that for the structural steel trade, on account of the many improvements which are now rapidly getting under way.

The American Pacific Cable.

On July 1st cable despatches were received announcing the completion of the entire line of telegraph, over 8,000 miles long, from San Francisco to the Philippine Islands, thus successfully terminating the most gigantic submarine cable enterprise ever attempted. During the next three days the final details were arranged whereby telegraphic communication was established completely encircling the globe, and on July 4th the President of the United States, from Oyster Bay, Long Island, flashed a message of congratulation to the President of the Commercial Cable Company, who, as it happened, was also at Oyster Bay. The message was filed at 11.23 p.m., and received at 11.35, just twelve minutes later. Meantime it had made a journey of some 25,000 miles, passing successively through New York, across the continent to San Francisco, under the Pacific Ocean to Honolulu, again under water to Midway Island, Guam and Manila, thence to Asia and Hong-Kong, under the China Sea, pausing at Saigon on the east coast of Indo-China and Singapore on the tip of the Malay Peninsula. Thence it passed up the Strait of Malacca, across the Bay of Bengal to Madras, next 700 miles overland to Bombay, whence followed the long trip through the Arabian Sea, the Red Sea, the Mediterranean and the Atlantic, the message being relayed at Aden, Suez, Port Said, Malta, Gibraltar, Lisbon, Azores, and Canso in Nova Scotia, from which latter point it finally returned to New York. The reply was sent in even more remarkable time, viz., 9½ minutes—although, as before, it was relayed at eighteen stations in the course of its travel.

Much interest attaches to the laying of this last cable in the chain of telegraphs around the world. On September 23rd, 1902, the cable steamship *Silvertown*, with the first section of the Pacific cable on board, left the English coast, arriving on December 4th at San Francisco. Having laid the shore end of the cable the vessel started for Honolulu December 15th, and arrived off the island on Christmas Day, having laid the cable at the rate of two hundred miles a day. Under separate contract the laying of the remaining sections—those from Honolulu to Midway, Guam and the Philippines—was undertaken by the Telegraphic Construction and Maintenance Company. For the purpose two special steamships were fitted up by the manufacturers, the *Colonia* and the *Anglia*, and these left London April 9th and 10th with more than 6,000 miles of cable in their tanks. The longest section—that between Guam and Midway—2,606 nautical miles, was laid by the *Colonia*, the largest cable ship afloat. Starting from Manila with the shore end laid, on May 24th, the *Anglia* arrived at Guam on June 2nd, and two days later that section was in working order. At Guam the engineering and electrical staffs were transferred from the *Anglia* to the *Colonia*, and the latter vessel proceeded to perform her share of the work, laying the cable from Guam to Midway, with but one interruption, at the rate of two hundred miles

per day, and communication was established over this line on June 19th. Here the *Anglia*, having in the meantime sailed direct to Midway, again took up the work, and finished the last section, that from Midway to Honolulu, in time to allow for the transmission of the wonderful message on July 4th.

Wind Breaks for High Speed Electric Cars.

The Pacific Electric Railway Company, of Los Angeles, Cal., has recently been making a series of experiments on the effectiveness of wind breaks in increasing the efficiency of its long distance inter-urban cars. The tests were made on the Long Beach division of the system extending from Los Angeles to the ocean, where a stiff wind is encountered, and were attended with results of a most remarkable character. Among the different shaped wind breaks that were tried was one which resembled the cow-catcher of a locomotive, its base being on a level with the floor of the car, and the knife-edge backbone extending upward at an angle of 45 deg. to the top of the car, while the sides rounded off in a convex curve till they coincided with the sides of the car. Eventually the forward part of the structure will be constructed of glass, so that the motor man may sit within the shelter of this hood and control the car without being disturbed. It was found that with this shield it required but 220 h.p. to make a speed of sixty miles per hour, whereas, without it, 290 h.p. was necessary—a saving of about 24 per cent. in power. Also at a speed of fifty miles per hour the result in favour of the hood was 137 h.p., as against 170 h.p. Mr. R. S. Masson, the consulting engineer of the company under whose directions the tests were made, declares that in the face of these highly satisfactory results there can be no doubt that the wind break will soon be adopted on all long-distance cars.

The Largest Freight Car in the World.

One of the greatest problems of modern engineering is the devising of means for transporting over long distances very heavy iron or steel castings, such as exceed the carrying capacity of the ordinary flat car or gondola. The Bethlehem Steel Company has recently constructed a special steel car for just these purposes, which in some respects may claim to be the most remarkable one ever built. The car weighs 196,420 lb., complete, and, as it is capable of carrying a load of 300,000 lb., the total weight of car and load reaches very nearly half a million pounds. Its main features consist of two large bridge trusses 66 ft. 10 in. long, connected together at the ends by short cross pieces which bear on the centres of two flat cars, each composed of shorter trusses supported on sixteen wheels, so that the entire load is borne by thirty-two wheels. At each end of the main double truss there is a mammoth king bolt to allow the trucks to turn independently when rounding curves. In the centre, where the load is carried, this truss is six feet deep, while at the ends it is tapered abruptly on the top and bottom edges, giving it a profile resembling that of a torpedo. Over all the car is 103 ft. $10\frac{1}{2}$ in. long; its greatest height from the tracks is 10 ft. $2\frac{1}{4}$ in., and it is 9 ft. 9 in. wide. The first test of the car was made recently, when some very heavy castings were shipped upon it to the Carnegie Steel Company for a 12,000-ton forging press. One of these castings weighed 325,000 pounds and required in its making six 40-ton open-hearth furnaces to supply the metal.

The Peculiarities of Selenium.

In a lecture given before the American Institute of Electrical Engineers, the speaker, Mr. W. J. Hammer, discussed, among other subjects, the remarkable characteristics of selenium, showing by lantern slides and experiments a few of its possibilities. The most distinctive property of the substance is the effect which light has upon its electrical resistance. This was illustrated experimentally by placing a selenium cell in circuit with a sensitive relay and a battery, and causing the armature of the relay, through the agency of a motor, to operate a switch for opening and closing an electric light circuit. An acetylene lamp was placed so that its light fell on the selenium, and the apparatus adjusted to maintain the switch in a closed position with the electric lights burning. Thereafter the mere passing of the hand between the lamp and the selenium was sufficient to cause a winking of the electric lights as the circuit was momentarily opened and closed again. The selenium cell used in this experiment had a normal resistance in the dark of about 200,000 ohms, which was decreased to 75,000 ohms when subjected to light. As one possible field of usefulness for the selenium cell it was suggested that it might be employed for the control of the gas supply to light buoys, the controlling mechanism to be operated by an electric current and the lighting of the gas effected by a spark. The setting and rising of the sun could thus be made to automatically light and extinguish the buoy lamp, and would afford a considerable saving in gas consumption and attendance.

Sinking a Mining Shaft Through Quicksand.

A novel method for sinking a mining shaft through a considerable quantity of swamp, ooze and quicksand is being tried by the Minnesota Iron Company, near Chisholm, on the Mesaba Range. The process is the patent of Captain Hoar, of Negaunee, and is described as follows: Two heavy sets or shaft frames, cased on the outer side with steel, are started, and outside of them long steel lined laths are driven downward. The laths fit closely together, and may be driven or jacked downward independently of one another, which allows for the surrounding of any obstructions that may be encountered. The sand and other material inside the laths are then removed, and the inside sets are driven down, the process being repeated to the bottom. The shaft is being sunk at the rate of 2 ft. a day, and altogether the process seems to prove a practicable one. The ledge of rock at the point where the shaft is being sunk is at a depth of about 90 ft.

GERMAN RÉSUMÉ.

BERLIN, August 20th, 1903.

Electric Tramways in Germany.

From the returns given in a recent number of the *Elektrotechn-Zeitschrift*, it may be inferred that the increase of electrically-operated tramway lines in Germany, during 1902, was about 300 kilometres, apart from about 400 kilometres which are in course of construction at the present moment, this making an aggregate of 3,800 kilometres. The total output of electrical machines has once more been increased to a high degree, *i.e.*, by more than 14 per cent., thus giving a total sum of about 124,000 kilowatts. Another important item is the output of the accumulators used in connection with the operation of the tramways, either as buffer batteries or to aid the machines. Here an increase of more than 17 per cent. as compared with last year is noted, the total output being now about 30,000 kilowatts (against 25,530 kilowatts last year). But the growth of electric tramways is best illustrated by the increase of the carriage department, the number of motor-cars being now about 12,500, as compared with 7,300 last year, and that of trailing cars about 8,000, against 5,000 last year, being an increase of 41 and 60 per cent., respectively.

The above return is purely technical, accounting neither for the questions connected with the operation nor for financial problems. The latter, however, are considered in a study recently published in the *Zeitschrift für Kleinbahnen*, the data given being relative to both electric and horse tramways. According to these statistics, there existed at the end of 1901 in Germany 186 tramway enterprises, with a working track 3,007 kilometres in length. Altogether 1,044 million persons were conveyed, and £5,000,000 was received. It is interesting to note that the fares are cheapest in Breslau and in Frankfort on-Main, viz., about 1·1d. per person. The dividends of the various companies range up to 19 per cent.

Though last year was especially unfavourable to the electrical trade in Germany there was nevertheless great progress in connection with electric tramways. But for this, the industrial crisis would have probably had much more serious results.

International Conference on Wireless Telegraphy.

This conference commenced its meetings on August 4th, representatives of the more important European countries and the United States being present. The following eight countries accepted the invitation received from Germany: England, France, Italy, Austria, Russia, Spain, Hungary and the United States, each appointing several representatives, so that the conference includes forty-four gentlemen, mostly members of the postal and telegraphic departments of their country. The conference is intended to prepare the way for an official regulation of wireless telegraphy between the countries concerned; its deliberations will therefore have an entirely provisional character. The first meeting took place at twelve o'clock noon in the great Hall of Sittings of the General Post Office, when Herr Krätke, State Secretary, welcomed those present in the name of the Government. The proceedings were presided over by Under State Secretary Sydow, it being decided to keep the deliberations private.

Exhibition of German Civic Life.

An exhibition intended to give a comprehensive view of modern institutions in great cities, by the aid of graphical and statistical representations, as well as by models, is being held at Dresden. This enterprise will afford any persons interested in the welfare and progress of German cities an opportunity of obtaining reliable data as to their achievements from a social or sanitary point of view, or with regard to public instruction, finances, municipal industrial concerns, saving banks, etc. Moreover, the results of numerous tours of inspection, made by municipal commissions, are to be recorded in a comprehensive manner.

This exhibition has been started on a suggestion by the Lord Mayor of Dresden, which resulted in a committee of 128 of the most prominent manufacturers being formed. It is located in the immediate neighbourhood of the Royal Gardens, extending over an area of about 20,000 square miles. The main Exhibition Palace has been erected by the City of Dresden, at a cost of £900,000.

The Charlottenburg Permanent Exhibition for the Welfare of Workmen.

This exhibition was opened on July 18th, consequent upon a meeting of the Reichstag (January 28th, 1903), when the necessity of such an enterprise was freely advocated. The exhibition is intended to afford to both inventors and manufacturers the means of showing in working order any machines and tools designed with a special view to the welfare of workmen. Two sections are provided for Industrial Hygiene and Accident Prevention respectively, the latter being the more extensive.

Museum for Achievements in Physical Science and Engineering.

A technical museum is about to be established at Munich, on a suggestion made by Dr. O. von Miller. A provisional commission has been formed which, in connection with the recent Congress of the *Verein Deutscher Ingenieure*, invited the most prominent exponents of both engineering and science in Germany to give their assistance to the work. This museum is intended to give a comprehensive view of the influence of scientific research on engineering, and to illustrate the historical development of the various branches of industry, especially by means of prominent and

typical masterpieces. Connected with the museum there is a Museum Association, and Pettenkofer's collection of physical instruments will form a part of the new institute.

Wireless Telephony Experiments.

Particulars as to the recent wireless telephony experiments by Herr Ruhmer made for weeks in the Kiel harbour have just come to hand. The following ships were used with these interesting trials: the watch-vessel *Neptun*, the iron-clad *Kaiser Friedrich III.*, and the little cruiser *Nymphe*, these vessels being provided with Ruhmer's instruments for wireless telephony. At the beginning, the tests took place in the bay of Wyk, the distance being small and most satisfactory results being obtained. Later on the distance was increased. Immediately before the beginning of the so-called Kiel Week, the final experiments were made. By the courtesy of the Emperor the *Nymphe* was allowed to leave the fleet stationed at the mouth of the Elbe before the manœuvres had ended, when she went to Kiel to have her share in the experiments. The latter took place in the Kiel naval port as far as Friedrichsport, and finally the *Nymphe* went as far as Stollergrund, the distance between the sending and receiving stations being now about 30 kilometres. The working of the instruments was excellent, and apart from some insignificant disturbances the effect obtained was most satisfactory. On the first day of the Kiel Week the Kaiser was present during the progress of the experiments, and some days previously the chief of the staff of the Admiralty, Vice-Admiral Büchsel, had convinced himself of the usefulness of the new system of transmitting news. At Stollergrund those present would distinctly hear the words spoken on board the *Neptun* anchoring near the Military Academy. The results ascertained by representatives of the navy as well as by experts fully prove the usefulness of the system for the navy. These experiments are likely to result in the official adoption of the Ruhmer system in the German Navy.

Professor Slaby's Experiments in Wireless Telegraphy.

That well-known experimenter in the field of wireless telegraphy, Professor Slaby, has been granted a subvention of £1,000 by the jubilee fund of German industry, for continuing his researches. We now learn that in connection with the conference above mentioned, a preliminary report has been presented to the Council. These experiments first dealt with the question as to the part played by the earth in connection with wireless telegraphy. By means of extensive zinc armatures on the ground of his laboratory the author was able to construct a sort of artificial earth, and to study the propagation of electric waves along the ground, when he announced the presence of stationary waves, giving evidence of the important *rôle* played by the conductive surface of earth. The theory of closed sending apparatus was not so far able to account for the distance effects of such sender types. Professor Slaby now succeeds in reducing them to the action of the upper harmonics and in establishing a novel theory, the results of which are in a most satisfactory accord with experiments. The author further dealt with the design of instruments enabling even unskilled persons to measure the wave length of a transmitting station. About a dozen different types have been experimentally studied and shown to be fully suitable. The author, we learn, is at the present moment engaged in studying new sender-types, it being anticipated that a better method of tuning different stations will be derived from these experiments, which are shortly to be recorded in an extensive treatise.

Electric Traction on the Berlin-Gross-Lichterfelde (Ost) Railway.

One of the numerous Berlin suburban railways, viz., the Berlin-Gross-Lichterfelde (Ost) line has lately been electrified. This line has a total length of 9·2 kilometres, the working section proper being 9·05 kilometres. A power station located at a distance of about 500 metres from Papestrasse station in the immediate neighbourhood of the Ringbahn will, by means of a 1,600 kilowatt machine, aided by the remaining tramway dynamos and by a buffer battery, furnish the working current for the whole of this line. The trains will at the outset comprise two third-class and two second-class motor-cars of a weight of about 123 tons, affording sitting accommodation for 206 persons. They are to be run at intervals of twenty minutes, these intervals being diminished to ten minutes in times of pressure. The introduction of a five minutes' service is contemplated in the near future. This suburban railway is operated with 550 volts direct current conveyed by means of three cables to a switch-board house located in the neighbourhood of the working station. Four cables will thence lead to the two current rails, two to each of them; these current rails are insulated as third rail along the two tracks, yielding the current to the 125 h.p. motors of the cars, whence it is led back through the running rails.

New Electric High-Speed Traction Experiments.

The new electric traction plant on the Berlin suburban line Johannisthal-Spindlersfelde is now so advanced that trials are likely to be started in the course of August. Between the State railway administration and the Union El. Company arrangements have been made for the trials to be finished in the course of not more than two years. The plant is being supervised by special State railway officials, and in the event of its proving satisfactory, the administration reserves itself the right of purchase. At Spindlersfelde Station there has been established a special track 80 metres in length with the necessary switching appliances, the electrical equipment of the track being connected to the Oberspree Power Station. As to the means of operation, the State railway authorities have placed at the disposal of the Union Company two six-axle carriages, fitted with compressed air brakes, which have been transformed into motor-cars. These motor-cars will, at the outset,

be run alone, the current used being mono-phase alternative current at a tension of 6,000 volts. By using the new type of alternative current motors it is intended rendering the current supply to railways nearly as simple as is now the case with tramways. Moreover, no transformation of the alternative current into direct current (in special transformer stations) will be necessary, thus ensuring a considerable saving in the cost. In the case of the motor carriage trials proving satisfactory it is contemplated running experimental trains, for which purpose three carriages are to be equipped as trailers. At the same time experiments with electric lighting and heating of trains are to be made.

Electrically Driven Looms.

It is gratifying that in the struggle going on between manufacturer and domestic industry in some parts of Germany, the latter should occasionally have its share also in the achievements of modern engineering. A co-operative enterprise with a view to supplying the domestic weavers (of the silk ribbon trade) in the Southern Black Forest with electric power has lately been started in the Hotzenwald district, it being contemplated to drive by electricity the looms of five hundred weavers living in twenty-eight different localities. The cost of establishment for the whole of the power plant is estimated at about £17,000, this sum to be supplied by the Wald-Elektra Säckingen-Waldshut Power Company, apart from a subvention granted by the Government. The significance of this enterprise is its enabling the above branch of textile industry to be preserved as a house-industry, securing a yearly income of about £15,000 to the poor inhabitants of that part of the Forest. Moreover, the diminution of strain on the physical strength and health of the weavers will allow of people of even moderate strength devoting themselves to domestic weaving without endangering their health, so that a rational division of work can be made between the members of the same family, especially during the season of rush in the silk trade. Moreover, weavers will be in a position to deal with stouter goods, securing them higher profits, apart from the sanitary advantages attendant on electric operation and lighting.

Working Brass and Related Copper Alloys.

This was the subject of a lecture by A. Hilpert lately delivered at Munich and recorded by *Dingler's Polytechn. Journal*. Brass and similar copper-zinc alloys, containing small percentages of zinc, as is known, are liable to be wrought by forging, pressing, rolling, etc., only in the cold state, whereas on being worked in the heated state, they will prove brittle. For higher amounts of zinc, however, beginning with 38–45 per cent., these alloys are readily wrought even at high temperatures, this property being increased, when small amounts of iron, lead, phosphorus, manganese, tin or aluminium are added. These forgeable alloys with low percentages of copper are wrought by forging, jumping, pressing or rolling. On account of the higher velocity of cooling, the working of these alloys should be finished in less time than in the case of iron. In order to obtain irreproachable surfaces and uniform thickness, sheet-metal and thin-walled tubes are wrought, rolled and drawn in the cold state. In the form of rods, both brass and delta-metal are now frequently brought to a hot state, by pressing, according to Dick's process, when several rods may be produced from one matrix. The diversity of cross sections of the rods allows of the material being prepared with a view to production on a large scale, according to the cutting-process.

The main advantages of pressing, as compared with rolling, are said to consist in the production of smoother surfaces with higher strengths, comparative experiments on rolled and pressed materials respectively giving the values recorded in the following table :—

Material	Tensile strength. Kg./sq. mm.		Shearing strength.	
	Rolled.	Pressed.	Rolled	Pressed.
Brass containing—				
60 per cent. copper	34·4	37·2	26·7	25·4
58 ,, ,, ,,	40·5	42·5	28·2	27·3
55 ,, ,, ,,	47·0	52·3	35·2	31·3
Muntz metal	50·5	54·6	—	—
Aluminium bronze...	55·0	65·3	—	—
Delta metal	73·3	76·6	—	—

The above figures show that the strength decreases with augmenting percentages of copper, the tensile strength of pressed material being greater, and its shearing strength lower than that of rolled material.

Electricity in Mines.

In a paper read at a recent meeting of the Chemnitz section of the *Verein Deutscher Ingenieure*, Herr Schreihage discusses the different types of current liable to be used in connection with power transmission in mines. Direct-current presents the advantage of ready regulation of the speed of the motors within rather extensive limits ; on account, however, of the impossibility of an adequate insulation, the use of economical high-tension currents of this kind is rendered impossible. Rotary currents, on the other hand, allow of high tensions being used with perfect insulation, though the number of revolutions be less easily regulated. That, however, in some special cases continuous current may as well be resorted to, is shown by the 2,800 h.p. direct current hoisting machine, as constructed by the Siemens and Halske Company for the Gelsenkirchener Bergwerks-A.G.

The author gives a comprehensive review of the different uses to which electricity may be put in connection with mining, the arrangements of motors, diagrams and systems of operation being especially dealt with, together with numerical data as to the economy of both the old and electric methods.

SOUTH AFRICAN RÉSUMÉ.

JOHANNESBURG, Aug. 10th, 1903

Johannesburg Sewerage Scheme.

The next large engineering undertaking contemplated by the Johannesburg Town Council is an extensive sewerage scheme to gradually displace the existing pail system of sanitation. At present, only the general outline of the proposed works has been settled, and the south-western district of the municipal area will be dealt with first. This contains about 14,000 acres, and has a difference of levels from the highest to the lowest point of 455 ft. The ultimate population of this district is estimated at 218,000, but in the immediate future at only 110,000. Of the ultimate total, it is assumed that 57,000 will be resident in the urban area, containing 1,456 acres, and in which better sanitation is most urgently required, and which will therefore be the first to be served, although, of course, the main outfall sewer will be equal to the requirements of the whole district.

The following particulars have been extracted from the comprehensive official report of Mr. D. Leitch, M.Inst.C.E., the town engineer. Owing to the rainfall being confined to the summer season, it cannot be relied upon for flushing purposes, and for the further reason that all available surface water is required by the mines, it is proposed to provide an entirely separate system of channels and culverts for surface drainage, and to exclude all rain-water from the sewers, except in special cases.

The sanitary system is based upon an allowance of 40 gallons of water daily per head of population, and the main outfall sewer will be oval in section, with dimensions varying from 1 ft. 8 in. by 2 ft. 6 in., to 2 ft. 4 in. by 3 ft. 6 in. It is proposed to construct this and the other large sewers of armoured concrete pipes (made in lengths of from 2 ft. to 4 ft.) in those parts of the system where they can be laid in open trenches, but in those places where it is necessary to build them in headings, concrete rammed round centering will be used. For carrying the outfall main across valleys the use of steel pipes supported on suspension bridges is recommended in the report.

It is proposed to call for tenders locally, and also in England, for the supply of stoneware and cement pipes, and the following estimates are given of the requirements for the urban portion of the area under consideration :—

Glazed stoneware sewerage pipes	£13,720
Glazed stoneware storm-water pipes . .	17,170
Additional for house connections . .	7,870
	£38,760
Armoured concrete sewers	£48,548
Concrete rings for manholes	1,237
	£49,785

In addition to the items already mentioned and the ironwork for gullies, manholes, ventilators, etc., there will be a considerable opening for manufacturers of sanitary appliances for houses. These, although provided by the individual owners, will be subject to regulations under which only the most modern and suitable types will be allowed. The following provisional estimate relates to the work for which detailed designs are now being prepared, and is exclusive of house connections and internal fittings :—

Storm water drainage in urban area . .	£203,400
Sanitary system in urban area	114,320
Outfall sewer to municipal boundary . .	56,740
Extension of outfall main and for disposal works	164,450
Sewerage of outlying townships in S.W. district	102,600
Total . .	£641,510

South African Ports and Transvaal Ports.

The following figures serve not only to show what a large market there is in the Transvaal for imported materials of all kinds at the present time, including foodstuffs, of course, as well as machinery and mining requisites, but they also give a rough idea of the distribution of the business between the several maritime States. The imports to the Transvaal during the first four months of the present year were :—

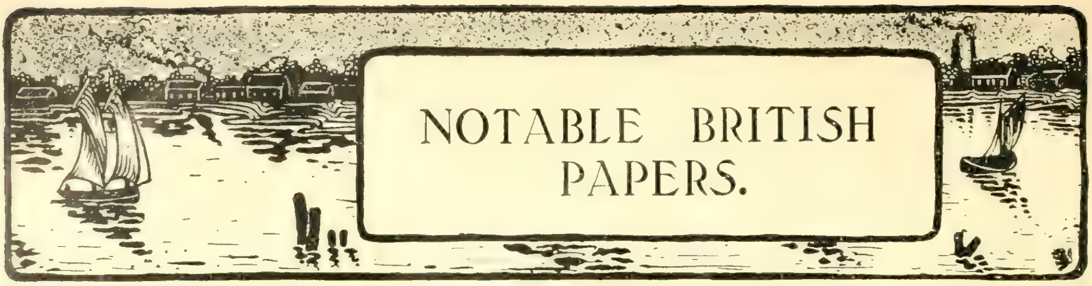
Via Natal	£3,423,365
,, Cape Colony	3,309,300
,, Delagoa Bay	1,226,345
Total . .	£7,959,010

Prospecting for Diamonds.

Both the Transvaal and Orange Free State are being well prospected for diamond mines just now, and several discoveries have been recently reported from the neighbourhood of Klerksdorp. Diamonds, however, differ from gold in that an enlarged production depresses their value more rapidly, and the discovery of too many mines may tend to defeat the object of the prospectors.

Johannesburg Tramways.

The tenders sent in for the supply of the material of the municipal electric tramway are being considered by the Municipal Council. The Tramway Committee recommend the acceptance of the Brush Electrical Engineering Company's tender for grooved and Vignoles rails and fishplates, of Belgian make, at £74,549, with 2½ per cent. discount. The British tenders for these are articles considerably higher.



A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE RAISING OF WATER FROM DEEP WELLS AND BORINGS BY COMPRESSED AIR.

MR. WILLIAM H. MAXWELL, Asso.-M.Inst.C.E., at the Bolton meeting of the British Association of Waterworks Engineers, contributed a paper on the above subject, having undertaken to do so, first, because in the year 1900 he installed an "air-lift" pumping plant at the Corporation waterworks, Tunbridge Wells, which plant has since been in constant use; and, secondly, because very little reliable information as to the working results obtainable by this system has hitherto been published.

The use of compressed air for power transmission has been a matter of careful study and experiment on the part of engineers for some considerable time past, but it is only during more recent years that the "air-lift" system has been applied to any practical extent to the raising of water from deep wells and borings in this country. In many cases of mining, tunnelling, rock-drilling, etc., the use of compressed air is the only available means of performing the services required, and the elementary question of fuel economy is of secondary importance under such circumstances.

The successful adoption of the system of raising water by the use of compressed air is likewise dependent upon the conditions peculiar to the case under treatment, and it is therefore essential that the waterworks engineer, before resorting thereto, should carefully consider whether the special circumstances of the case are such as to fully warrant its adoption.

DESCRIPTION OF TUNBRIDGE WELLS PLANT.

The main factor which influenced the decision to apply the "air-lift" system at Tunbridge Wells (which decision was arrived at prior to the author's appointment as waterworks engineer), was the possibility of operating the boring from the existing pumping station and avoiding the erection of any buildings, foundations, or machinery requiring personal supervision at the site of the boring, which is situated some 530 yards away from the pumping station. The boiler power was also sufficient to supply the steam required for the compressors without any additional boilers, settings, or buildings for same, and the air-compressing plant involved no extra attendance, as a new steam pumping plant was then being installed, and one extra mechanic was able to attend to both sets of plant.

The compression is carried out in two stages, the first to a pressure of 25 lb. per square inch, and the second, after intercooling, to the pressure required, which varies from 90 lb. to 100 lb. per square inch. according to the depth of the water in the boring. The air is delivered into a large steel receiver situated in the engine-house, whence it is conveyed to the wells by means of a 4-in. cast-iron pipe. This main is formed of ordinary spigot and socket pipes with lead joints, which, however, shortly after starting the plant, showed signs of leakage adjacent to the receiver. This was traced to the expansion and contraction of the pipes due to the high temperature of the air, and was effectually prevented by fixing a cooler on the air-pipe between the second stage compressor and the receiver.

There are two sets of engines and compressors designed to deliver a sufficient volume of air to lift the desired quantity of water, if needs be, over a standpipe 20 ft. high above ground level. The engines are compound, with cylinders 8 in. and 12 in. diameter respectively, the air-compressing cylinders being 10 in. (first stage) and 6 in. (second stage) diameter respectively. The stroke in each case is 14 in. The air-cylinders are water-jacketed at sides and covers, The clearance in the air-cylinders does not exceed 1 per cent. of the capacity. The air is drawn from outside the building, and is carried in an earthenware pipe under the floor to the inlet valves, so that it enters the compressors at the lowest possible temperature.

The inter-cooler (between first and second stages of compressors) is formed of a series of "Rows" tubes cooled by circulating water. This is also fixed outside the engine house.

Provision is made for draining off the water which is precipitated in the receiver owing to the compression of the air, and, similarly, any oil carried forward by the air from the cylinders is also precipitated here, and drained away from time to time. As a further

safeguard, another trap is provided near the boring for the same purpose. In some cases, however, the receiver is filled with coke in order to arrest any oil carried forward with the air.

The boring is 350 ft. deep, penetrating the Wadhurst clay to a depth of 204 ft. 6 in., and the Ashdown sands to a further depth of 145 ft. 6 in. The upper portion is lined with 15-in. steel tubes, and the lower portion (150 ft.) with steel perforated tubes, 13½ in. diameter. The rest level of the water is about 96 ft. from the surface, and the pumping level, when drawing at the rate of 32,000 gallons her hour, is about 120 ft. from the surface, but on the cessation of pumping the water resumes its rest level very rapidly.

The water pipe, or rising main, is 7 in. diameter, and is carried to within a few feet of the bottom of the boring. The air-pipe was originally 1½ in. diameter, but was subsequently increased to 2½ in. diameter, an alteration which reduced the air pressure required from 105 lb. to 91 lb. per square inch, the latter figure corresponding very closely to the head of water above the bottom of the air-pipe, and thus proving the loss by friction to be reduced to a minimum.

In a trial run for 10¼ hours made soon after the plant was installed, an average of 31,402 gallons per hour was raised from this boring under a head of 133 ft., whereas an ordinary single-acting pump, such as could be fixed in a boring of this small diameter, would not give more than about 18,300 gallons per hour.

The plant was made and erected by Messrs. Hughes and Lancaster, of London and Ruabon, and the cost, including two compressors with compound engines, air main, air and water pipes in borings, condenser feed and air pumps, was £3,374 17s. 6d.

COMPARISON BETWEEN DIFFERENT SYSTEMS OF PUMPING.

Having to provide pumping plant for a boring 15½ in. diameter and 400 ft. deep, situated in an isolated and somewhat inaccessible position, the author has made a careful estimate of the comparative cost of pumping and maintenance with the three alternatives of (1) "air-lift," (2) steam engine, and (3) oil engine—both the latter operating ordinary borehole pumps, and in each case taking into account the capital charges involved. The results are shown in the following statement, the lift being assumed as 100 ft., and the working hours 3,000 per annum :—

1. COMPRESSED AIR PLANT.

	d.		
Capital charges, labour, and repairs	1·16	per 1,000 gals.	
Fuel as per test, October 7th, 1902	1·073	,,	,,
Total	2·233	,,	,,

2. STEAM ENGINE AND BOREHOLE PUMP.

	d.		
Capital charges, labour, and repairs	2·4	per 1,000 gals.	
Fuel (average of tests by the author)	0·5	,,	,,
Total	2·9	,,	,,

3. CHEAP FUEL OIL ENGINE PLANT AND BOREHOLE PUMP.

	d.		
Capital charges, labour, and repairs	1·53	per 1,000 gals.	
*Crude oil fuel	0·25	,,	,,
Total	1·78	,,	,,

ADVANTAGES AND DISADVANTAGES OF "AIR-LIFT" SYSTEM.

In conclusion, the author will summarise some of the most important general features of the "air-lift" system as ascertained from his own experience. The most suitable conditions under which the system may be applied appear to be those which exist at Tunbridge Wells—viz., where a boring is situated in an isolated and somewhat inaccessible position and the air-compressing plant can be placed on an existing pumping

* At a trial of a crude oil engine plant, working at Grantham, the cost of fuel averaged only 0·183d. per 1,000 gallons raised 100 ft., the price of crude oil being 2½d. per gallon.

TABLE I.

TESTS OF "AIR-LIFT"—TUNBRIDGE WELLS WATERWORKS.

1	2	3		4		5	6	7	8	9	10
Date of test.	No. of Test.	Water Levels Below Ground Surface.				Average Rate of Delivery per hour in Gallons.	Cubic Feet of Water Delivered per Minute.	Cubic Feet of Air per Minute (Atmospheric Pressure).	Volumes of Free *Air* to 1 of *Water*.	Ratio of Immersion of Air Pipe to Lift.	
		Start.		Finish.						At Start.	At Finish.
		ft.	in.	ft.	in.						
June 3rd, 1901	1	84	0	106	0	24,100	64·3	173·6	2·69	3·01 to 1	2·2 to 1
April 11th-17th, 1901	2	89	0	130	9	29,055	77·5	377	4·8	2·8 to 1	1·6 to 1
July (latter part), 1901	3	94	0	124	0	30,446	81·2	285·3	3·5	2·0 to 1	1·72 to 1
July 14th-20th, 1902 ...	4	120	0	158	6	19,785	52·8	447	8·4	1·8 to 1	1·13 to 1
October 7th, 1902 ...	5	103	9	125	9	27,636	73·7	421·8	5·7	2·27 to 1	1·69 to 1
October 21st, 1902 ...	6	109	7	124	6	27,187	72·7	398	5·4	2·1 to 1	1·71 to 1
February 12th, 1903...	7	96	6	112	8	26,289	70·1	260·5	3·7	2·46 to 1	1·66 to 1

NOTE.—The fuel cost per 1,000 gallons raised, Test No. 5, with water levels varying between 103 ft. 9 in. and 125 ft. 9 in., was 1·073d., with coal at 25s. 5d. per ton. During the early months of the present year (1903), with water levels between 98 ft. and 118 ft. below surface, the fuel cost was ·97d. per 1,000 gallons.

station, involving but little outlay in the erection of new foundations or buildings, or the purchase of additional land, and without incurring the provision of additional labour at the site of the boring. To secure satisfactory results, however, it is important that the difference between the rest level and the pumping level of the water should not be excessive, that the fluctuations of the same should be ascertained beforehand, and that the ratio between the immersion of the air-pipe and the total lift of the water should be adjusted to the most suitable proportions, and not greatly varied in ordinary working.

Although it cannot be denied that the cost of fuel involved by the "air-lift" exceeds that required with a steam or oil driven pump of the ordinary form, yet the author believes that, *under suitable conditions*, the former will prove to be preferable, taking all charges into account in each case. The absence of any moving parts in the boring secures a great reduction in the cost of repairs and maintenance, as well as in supervision and all other charges incidental to an additional pumping station. There is also a great advantage in the use of the "air-lift" in cases where the water contains iron, as the aeration is carried out very thoroughly in the boring, and after the water has reached the surface, the precipitation of the iron takes place more speedily. On the other hand, the system is by no means suitable to all circumstances, and should not be resorted to unless the conditions of working are specially favourable to its use.

ELECTRICAL UNDERTAKINGS.

A USEFUL and interesting paper was read before the Institution of Mining Engineers by Mr. T. P. Osborne Yale on "Electric Power Distribution by Continuous Current for Mining and General Purposes in North Wales." The paper was chiefly designed to illustrate the way in which the supply of electricity, either public or private, in this country, is hampered by existing laws; and how, under exceptional circumstances, a supply may be given to the public without statutory powers. It also dealt with some of the points to be considered in deciding on the use of the 3-phase or continuous current in this country.

The district with which the paper was concerned lies in the north-eastern corner of Merionethshire, and has long been one of the great centres of the slate industry.

Power is chiefly required at Blaenau Festiniog for haulage on the inclines, for sinking and for pumping; and also for driving the mills and repairing shops. Referring to the reasons which induced him to advise the adoption of the continuous current system, the author remarked that:—

He is entirely in favour of the use of 3-phase current when the limits of low-pressure can profitably be exceeded, but it must be understood that although the Board of Trade declare the limits of low-pressure for continuous current to be 500 volts, they place the limit for 3-phase current at 250 volts. Otherwise, he considers that each system must be considered on its merits in relation to any particular case.

With regard to the case under discussion, the reasons for adopting continuous current were as follows: (1) The Board of Trade limits for low-pressure are only 250 volts for 3-phase whilst they allow 500 volts for continuous current. This fact alone was sufficient to decide in favour of the latter. (2) Even if it had been permissible to employ 3-phase current at the same voltage as continuous current, namely, 500 volts, then the weight of copper in the line would have been about 50 per cent. greater, for the same efficiency. (3) The regulations, generally, are more favourable to continuous current. (4) There was less likelihood of disturbance to telegraph and telephone lines from continuous than from 3-phase current.

Discussing the present state of the law regarding electrical undertakings, the writer urged the following reforms:—

(1) The No. 3 regulation of the Board of Trade, limiting the pressure of supply to a consumer to 250 volts, should be modified very much in favour of higher pressure for power, as distinct from house-lighting purposes, without having to obtain special permission, which complicates matters and may even stop progress altogether in many cases. Of course, such higher pressure would be subject to regulations for the public safety the same as all existing lines. (2) No. 14 regulation requiring that "no high pressure aerial line shall be used to transmit more than 50 kilowatts (that is about 67 h.p.)" without the consent of the Board of Trade, should be abolished; and (3) other regulations should also be amended in accordance with the preceding suggestions, and the absolute veto of the local authorities should also most certainly be done away with.

There was a somewhat prolonged discussion, which, however, had a practical outcome, for Dr. Le Neve Foster proposed the formation of a committee to inquire into the points raised. In doing so, he desired it to be understood that he had not the slightest feeling of hostility to the Board of Trade. He felt sure that these restrictions were made by the Board of Trade originally in perfect good faith and with a desire to preserve human life. He moved the following resolution: "That the Council be empowered to appoint a committee to consider the present restrictions imposed by law on the transmission

of electrical power, and to take such steps as they may deem advisable."

Mr. Mitchieson seconded, and the resolution was carried *nem. con.*

FIRE PREVENTION IN COAL MINES.

AN important paper on Underground Fires was read before the International Fire Prevention Congress by Professor F. W. Hardwick, M.A., A.M.Inst.C.E., who dealt with these conflagrations in two classes: (1) Fires due to various causes—chiefly ignition of coal, timber, or other combustible material in the mine; and (2) fires due to the spontaneous combustion of coal or bituminous matter.

MINIMISING RISKS.

The prevention of fires under Class I. is a matter of care and foresight, and in several cases where such fires have occurred, rules have been enforced in order to prevent their recurrence.

The prevention of fires under Class II. is generally attempted by the adoption of some special system of working or by alterations in the ordinary systems to meet the particular case. Very often the utmost that can be done is to minimise as far as possible the risk.

REMOVAL OF SLACK.

1. By removing from the working places all slacks or any material which may be liable to spontaneous combustion, and sending it out to the surface. In many seams small coal below a certain size is not sent out, or only a proportion of it is sent to the surface; the small coal which is not sent out is thrown into the goaf—the open space from which the coal has already been extracted. If this slack when left in the mine causes gob fires, it is better to incur the expense of sending it out of the mine than to leave it to fire. The same applies to bands of dirt or to impure coal which may occur in connection with the seam, or on the sides of faults.

EXCLUDING AIR FROM THE GOAF.

2. By excluding the air from the goaf or from any place in which heating is liable to take place. In longwall working the "gates" (that is, the roads along which the tubs for carrying coal are taken into and out of the working places, and which serve as roads along which the men and the ventilating current can travel to the coal face) follow the advance of the coal face. Consequently they have to be maintained through the goaf or gob (the space from which the coal has already been removed by the advancing coal face) by means of pack walls, built of stones laid on one another without mortar. These packs, though they become compressed by the weight of the strata overlying the seam, are seldom airtight; hence, if heating occurs in the goaf, the air is liable to scale through the pack into the goaf, and oxygen is supplied to increase the heating. In order to prevent this, the gate packs are sometimes lined with clay lumps to prevent leakage of the air, in other cases sand, or finely-ground ashes, are employed for the purpose of making the packs airtight. If the air current in passing along the coal face scales into the goaf and produces heating, sand or clay lumps are somewhat similarly applied to prevent infiltration of air. In some cases the waste packs (the packs put up in the coal face between two gates) are placed chequerwise, like the squares on a chessboard, to block the air out of the goaf; in other cases the whole goaf is stowed as tightly as possible; this, however, is rather a Continental than an English method, close stowing of the goaf being far commoner abroad than in England; the material used for stowing must, of course, be non-inflammable.

SPECIAL SYSTEM OF WORKING.

3. By adopting a special system of working. The method of working adopted in South Staffordshire for the thick coal may be instanced. The coal is won by driving a pair of roads to the boundary in the solid coal, and opening chambers or sides of work out of these roads. Only one side of work is opened at a time, and as it has only two entrances, these can be stopped off directly the coal shows signs of firing; when stopped off it does not interfere with the working of the rest of the coal as it lies on the inbye side (*i.e.*, is further away from the shaft) of the next side of work opened out, and is separated from it and others which may be opened near it by ribs of solid coal. A full description of this method of working will be found in the works mentioned in the footnote.*

In working a coal seam liable to fires on the pillar-and-stall system, the area of coal is divided into small panels or districts separated from one another by ribs of solid coal. The coal in such districts can be worked out more quickly if the districts are small; the number of openings into the districts being few, they can be stopped off more quickly, and the diminution of "pit room" (*i.e.*, coal laid out ready for working) is less seriously felt than if the districts are large.

WORKING HOME.

4. By working home. In the majority of cases coal is worked outwards away from the pillar left to protect the shafts, consequently in a colliery which has been working for some years a large area of goaf intervenes between the shafts and the working faces; if fires are liable to occur in any part of such a goaf, the danger and inconvenience can easily be imagined. In working home the operation is reversed, the roads are driven in the solid coal to the boundary, and the coal face retreats daily towards the shafts, consequently the goaf and its dangers are left behind. This system has the disadvantage of determining from the commencement the area

* "Text-book of Coalmining," H. W. Hughes. "Transactions" Inst. Mining Engs., iii., page 25. Clark and Hughes, xvi., page 487. Haldane and Meachem. "Proceedings" British Society of Mining Students, Hughes, ix., page 4.

of coal which can be worked from the shafts, and also of heavy initial expense in opening out, when the output of coal coming out can only be comparatively small.

RAPID WORKING, &c.

5. By rapid working. If the coal face advances slowly, the air-current which ventilates it has time to make its way into the adjacent goaf and cause heating ; the quicker the face advances the less likelihood is there of this action taking place.

6. By passing a strong current of cool air through the place which is heating in order to cool it and carry off the heat as fast as it is generated. If this is not possible, then the access of air to the place should be cut off altogether so as to deprive it of oxygen.

The author then describes the various means of extinction by filling out the fire, stopping it off, drowning it out, or using carbonic acid gas.

PRECAUTIONS AGAINST NOXIOUS GASES.

What reactions take place actually in the course of an underground fire does not appear to have been accurately ascertained, and the nature of the gases given off must therefore be a matter of conjecture. It would appear, however, that a fire in any mine must generate carbonic acid gas and carbon monoxide, while a fire in a colliery will generate in addition carburetted hydrogen and sulphuretted hydrogen.

It is the presence of these gases which offers so great a difficulty in dealing with underground fires and in recovering a mine after an explosion. The work of re-opening a mine or district that has been sealed off to extinguish a fire is attended with similar risks.

In order to enable necessary work to be carried on in these irrespirable gases, attempts have been made to enable persons to enter mines in which such gases were present, by arrangements similar to those used by divers. Of late years a contrivance known as the pneumatophor has been introduced into this country from Germany. This may be described as a bag or knapsack, which can be worn on the chest or back fitted with a small cylinder of oxygen, a glass flask fitted with a solution of caustic soda, and a coarse net or sponge to suck up the caustic soda solution when it is set free. The bag is connected by means of a pipe with the wearer's mouth, and his nose is closed by means of a clip. In this way the man wearing the pneumatophor is independent of the external atmosphere, and breathes only the atmosphere contained in the bag. The deficiency of oxygen caused by his breathing is made up from the oxygen cylinder, while the carbonic acid gas given off by the breath is absorbed by the caustic soda. Such appliances are used already in Austria and Germany, and in England Mr. W. E. Garforth has fitted up at Altcfts Colliery an experimental gallery for training men to their use. On the Continent regular rescue stations have been organised, and recently in South Yorkshire three collieries have united to form a joint rescue station. Such a rescue station is equipped with a number of these pneumatophors and accessories, and with oxygen and everything needful for the recovery of persons who have been overcome by noxious gases ; in connection with it there is a trained corps of officials and workmen who can use the pneumatophor and work with it, and arrangements are also made for furnishing first aid to persons found injured in the mine. At the mining school at Bochum, in Westphalia, a number of the students are trained each year in the use of the pneumatophor. Useful as the apparatus may be made by a person used to wearing it, and working with it, evidently its use by an unskilled person might only lead to danger to the wearer.

CANADIAN RAILWAYS.

THE proposed important developments in Canadian railway construction make it interesting to review the remarks on railway progress in Canada, which were made by Dr. Martin Murphy in the course of his presidential address to the members of the Canadian Society of Civil Engineers. The following is an abstract from this section of the address :—

If we look at our railway record, we find that much has been done within the past few years in the furtherance of railway construction. If, as it is said, one of the best tests of the commercial importance of a country, as well as the intelligence and progressive character of its people, both absolutely and relatively, is that of the extent of its railway traffic, we are climbing in the scale of the progress of the time.

A REMARKABLE FEATURE OF CANADIAN RAILWAY FINANCE.

One remarkable feature of the railway finances of the more important colonies is the ready acquiescence of the inhabitants to tax themselves for transportation facilities. Thus, we find that, while the total expenditure incurred on Canadian railways up to the end of the financial year ending June 30th, 1901, was $1,042,785,539.00, the several Governments and municipalities had contributed $228,539,890, of which $13,675,383 is still to be paid, or about 22 per cent. of the total. Of this proportion, the Dominion Government furnished $124,501,269, of which $8,342,538 is still to be paid ; the Provincial Government over $35,453,724, of which $3,058,201 is still to be paid, while the municipalities, as such, contributed over $18,584,898, of which $2,274,644 is still to be paid, in all.

The three lines of railway, viz., the Canadian Pacific, the Grand Trunk, and the Intercolonial, with their tributaries, contain 64 per cent. of the whole railway system of Canada.

The Canadian Pacific stretches across the entire continent, from Montreal to Vancouver, on the coast of British Columbia, a distance of 2,906 miles. Starting from the sea ports of Quebec and St. John, N.B.,

the lines run to Montreal (the headquarters of the Company), where the trans-continental line proper begins, passing through Ottawa, Calgary, and Stephen—the last named on the summit of the Rocky Mountains—and then through the Selkirk range to Vancouver, on the Pacific coast. The share capital amounts to $159,503,000. The total length of the Canadian Pacific Railway system is 7,563 miles, 300 of which are cut through solid rock. The road was opened for general traffic on June 28th, 1886, since which time there has been a daily mail service between the Atlantic and Pacific coasts. The distance from China Japan, and the Pacific coast generally, is from 1,000 to 1,200 miles less by the Canadian Pacific Railway than by other routes.

The Imperial and Dominion Governments having granted the Canadian Pacific Railway annual subsidies of $218,970 and $73,000 respectively, a mail service has been established between England and China over this line, the distance being shortened by several days, and the overland journey being entirely through British territory. Steamers have been built in England specially for this service, and mails have been landed in London within twenty-one days from leaving Yokohama.

The Grand Trunk was originally formed in 1853 by an Act of Legislature, and in 1893 the following lines were consolidated, viz.: Grand Trunk, Great Western, Midland Georgian Bay, London, Huron and Bruce, Wellington, Hamilton, Northern and North Western, North Simcoe, Montreal and Champlain, Beauharnois, Jacques Cartier, Waterloo Junction, and Cobourg, Blairton and Marmora, thus forming a continuous line through the provinces of Quebec and Ontario. The total paid-up loan and share capital of the company in June, 1901, amounted to over $376,978,318. The mileage of the lines owned and leased is 3,508 miles, in addition to which the company controls 674 miles in the States of Michigan, Indiana, and Illinois, making the mileage of the entire system 4,182 miles. The eastern extremities of the line are Quebec and Portland, Maine, and it extends westward to Detroit, Chicago, Grand Haven, and Muskegon, supplying the means of communication with Montreal, Toronto, Hamilton, Niagara, Buffalo, Detroit, and all the principal cities and towns in the provinces of Quebec and Ontario.

THE INTERCOLONIAL.

The Intercolonial Railway of Canada and the Prince Edward Island Railway owned and operated by the Dominion Government of Canada, are the great thoroughfares for travel through the provinces of Quebec, New Brunswick, Nova Scotia, and Prince Edward Island. The mileage of the Intercolonial is 1,315 miles and of the Prince Edward Island Railway 209 miles. The building of an inter-provincial railway was one of the stipulations embodied in the British North America Act, 1867; and in November, 1872, the already partly constructed Intercolonial Railway, together with the Nova Scotia Railway and the European and North American Railway, were consolidated under the name of the "Intercolonial Railway of Canada." The railway was extended to Montreal on March 1st, 1898. It is the only railway connecting Nova Scotia and the greater part of New Brunswick with the rest of the Dominion of Canada, and connecting Montreal, Levis, Riviere du Loup, Campbellton, Moncton, St. John, Halifax, Sydney, and North Sydney. At North Sydney, connection is made with the Reid Newfoundland Company's steamship line for all points in Newfoundland. Between Prince Edward Island and the mainland there is connection throughout the year by steamship service.

CHARACTERISTICS OF CANADIAN RAILWAYS.

Larger engines, larger cars, greater space, fast time, more convenience, and better and more accommodation are the characteristics of the time. Railway companies vie with each other in promoting traffic by keeping up with the requirements of the time, and in this respect we have little to complain of. You cannot find in Europe better equipped passenger and freight trains than those seen daily leaving Montreal stations. One of the through trains leaving Montreal to-day, moving quietly out with every carriage and van in a trim and uniform outline, in width and length, would compare favourably with any train leaving any European station, whilst our passenger accommodation will be found no less favourable.

BUSINESS AND PROFESSIONAL.

RECENT contracts secured by Messrs. Mellowes and Co., Ltd., of Sheffield, and 28, Victoria Street, Westminster, provide for glazing on the "Eclipse" Patent Imperishable system the roofs of the Ipswich Electric Station and Car Sheds; Yoker Generating Station; the Gas Works, Tynemouth; Motherwell Generating Station; Bath Generating Station, etc.

The British Steam Specialities, Ltd., announce that they have taken over the London premises (73, Farringdon road, E.C.) of the Exhibit and Trading Company of Liverpool, and have been appointed selling agents for their plumbing and other goods.

COMING EVENTS.—September.

1st.—Iron and Steel Institute. Autumn Meeting commences at Barrow-in-Furness.

2nd.—Institute of Mining Engineers. General Meeting at Nottingham.—Midland Counties Institution of Engineers. Meeting at Nottingham.—Iron and Steel Institute. Autumn Meeting (continued).

3rd.—Institute of Mining Engineers. General Meeting at Nottingham (continued).—Iron and Steel Institute Autumn Meeting (continued).

4th.—Institute of Mining Engineers. General Meeting at Nottingham (last day).—Iron and Steel Institute Autumn Meeting (last day).

SOME RECENT PUBLICATIONS.

"EMERY GRINDING MACHINERY."

A Text-book of Workshop Practice in General Tool Grindings, and the Design, Construction and Application of the Machines Employed. By R. B. Hodgson, A.M.Inst. Mech.E. 143 illustrations. Charles Griffin and Co., Ltd. 5s. net.

ALTHOUGH not laying claim to exhaustiveness the author has succeeded in producing a useful handbook of workshop practice which should prove of service to those for whom it is intended, viz., manufacturers engaged in mechanical and metal-working industries, tool makers and machinists, and students and workshop apprentices generally. The following is a synopsis of contents :—Tool Grinding, Emery Wheels, Mounting Emery Wheels, Emery Rings and Cylinders, Conditions to Ensure Efficient Working, Leading Types of Machines, Concave and Convex Grinding, Cup and Cone Machines, Multiple Grinding, "Guest" Universal and Cutter Grinding Machines, Ward Universal Cutter Grinder, Press, Tool Grinding, Lathe Centre Grinder, Polishing.

"EXPERIMENTS WITH VACUUM TUBES."

By Sir David L. Salomons, Bart., M.A. With portrait and 54 illustrations. Whittaker and Co. 2s.

VACUUM tubes were formerly among the "Babies" of Science, but the researches of Sir William Crookes and the evolution of X-ray photography have rendered the subject one of practical importance, and an independent inquiry into the phenomena connected with vacuum tubes, like that of Sir David L. Salomons, Bart., cannot fail to be of value in the progress of discovery, though the author has made no attempt to propound a theory. The experiments represent the labour of many years, and should be of the greatest interest to all those who are making investigations in the same field. As the author indicates in his preface, the work is not one that will appeal to a large public. The minority, however, will heartily welcome the experiments and also the results that are promised by Sir David L. Salomons at a future date.

"SOLUTIONS OF THE EXAMPLES IN THE ELEMENTS OF HYDROSTATICS."

By S. L. Loney, M.A. Cambridge University Press. 5s.

THESE solutions form a companion volume to the solutions of the questions in the author's "Elements of Statics and Dynamics," and, as such, will, no doubt, be found useful by a large number of students.

"CASSELL'S CYCLOPÆDIA OF MECHANICS."

Edited by Paul N. Hasluck. (Third Series. With 1,270 illustrations and an Index of 9,000 items. Cassell and Co., Ltd. 7s. 6d.

ONE of the most pleasing features of this volume is its complete index, affording ready access to a wide storehouse of information. Another strong point is made of the illustrations in line, which appear throughout. The subject matter deals effectively in paragraph form with many subjects interesting both to the mechanic and the general reader, and the work is a valuable addition to the bookshelf, either for occasional reference or random reading.

"SYREN CARTOONS."

One Shilling.

THIS selection of cartoons, reprinted from *The Syren and Shipping*, is published at a time when an increasing interest is being taken by the public in shipping affairs, and contains much that is bright and amusing. Pressure on our space prevents a detailed description of the clever drawings included. They are the work of Ernest Stuart, W. A. Donnelly, R. Oscar Longmire, and Oswald Rimmer, and must be seen to be appreciated.

"INDEX OF THE TECHNICAL PRESS."

In English, French and German. Monthly. 4s. per annum. Association de la Presse Technique, Brussels.

A VALUABLE undertaking which deserves far-reaching support. The various articles of interest to technical men are carefully classified under the decimal system, so that a cumulative index of ever-increasing value may be made by cutting out the entries, which are printed on one side of the paper only, and mounting them on cards. The technical press is thus provided with an important accessory, and we heartily wish the promoters success to their enterprise.

"THE DYNAMO: HOW MADE AND HOW USED."

By S. R. Bottone. Twelfth edition. Revised and enlarged, with numerous illustrations and instructions for making alternators. 170 pp. 8vo. S. Swan, Sonnenschein and Co., Ltd. 2s. 6d.

IN this little book the A B C of the dynamo is clearly explained, and to the present edition several sections treating on alternating dynamos have been added. The author has also re-arranged under more convenient heads the matter referring to the construction of large dynamos, and has devoted a special chapter to failures and their causes.

"CAPE COLONY FOR THE SETTLER."

An account of its urban and rural industries, their probable future development and extension. By A. R. E. Burton, F.R.G.S. Issued by order of the Government of the Cape Colony. London: P. S. King and Son. South Africa: J. C. Juta and Co. 2s. 6d. net.

THERE should be a wide demand for this volume, for it places at the disposal of intending settlers in cheap form a large amount of classified information, together with maps, tables and rainfall, etc. It is chiefly of interest from an agricultural point of view.

"A TEXT-BOOK ON MARINE MOTORS."

Being a description of most of the leading types of various marine motors as now manufactured. By Capt. E. Du Boulay (late Royal Artillery). With 90 illustrations. Offices of "The Yachtsman," 143, Strand, W.C. 12s. 6d.

THE author, in a hundred and fifty attractive pages, draws attention to forms of propulsion which he asserts will very shortly "bring about a mild revolution in yachting." Information of a readily-assimilated kind giving the salient points of the different systems is here supplied, the author first devoting several pages to the different oils employed. The principles underlying the working of heavy oil engines, light oil engines, steam engines with oil fuel and electric engines, are described, with many illustrations of typical motors. The work includes many practical hints, and should be of great assistance to the tyro who is unable to decide for himself as to the most suitable type of motor.

"SPECIFICATION FOR A LANCASHIRE BOILER AND BOILER SEATING."

By Inspector, M.I.M.E., Manchester. Technical Publishing Co., Ltd., Manchester. 5s. net.

A TWENTY-FOUR page booklet with diagrams, giving a complete specification for a Lancashire boiler, together with a few preliminary observations on the main features to be kept in view. The author remarks that to many people the seating of a Lancashire or Cornish boiler is one of the many little jobs that may be left to any local builder or mason, but this is a mistake. The seating is dealt with in a separate contract.

"PRACTICAL EXERCISES IN LIGHT."

By Reginald S. Clay, B.A., D.Sc. Macmillan and Co., Ltd. 2s. 6d.

DR. CLAY, who is the principal of the Northern Polytechnic Institute, has incorporated in this volume a great number of laboratory notes prepared for his own students. Interesting experiments, with simple apparatus, are outlined, and the text-book more than covers the requirements of candidates for the Advanced Stage Examination in Light of the Board of Education, South Kensington.

BOOKS RECEIVED.

The Hardening and Tempering of Steel. By Fridolin Reiser. Scott, Greenwood and Co. 5s. net.

The Proportions and Movement of Slide Valves. By William Dyson Wansbrough. Technical Publishing Company. 4s. 6d. net.

The Resistance and Power of Steamships. By W. H. Atherton, M.Sc., and A. L. Mellanby, M.Sc. Illustrated. Technical Publishing Company. 5s. net.

Electric and Magnetic Circuits. By Ellis H. Crapper, M.I.E.E. Illustrated. Edward Arnold. 10s. 6d. net.

Institution of Electrical Engineers. Form of Model, General Conditions Recommended for Use in Connection with Contracts for Plant, Mains, and Apparatus for Electricity Works. E. and F. N. Spon. 1s.

Elementary Treatise on Electricity and Magnetism. By G. Carey Foster, F.R.S., and Alfred W. Porter, B.Sc. Second Edition. Longmans and Co. 10s. 6d. net.

The Mechanical Engineers' Pocket Book of Tables, Formulæ, Rules, and Data. By D. Kinnear Clark. Revised and enlarged by H. H. P. Powles, M.I.M.E., A.M.Inst.C.E. Crosby, Lockwood and Son. 6s. net.

Graphical Statics Problems. With diagrams. By W. M. Baker, M.A. Edward Arnold. 2s. 6d.

Lathes, Screw Machines, Boring and Turning Mills. A Practical Treatise on the Design and Construction of Turning Machines, including Lathes, Automatic Screw Machines, Boring and Turning Mills, and their Accessories. By Thomas R. Shaw. With 425 illustrations. Scientific Publishing Company, Manchester. 15s. net.

Electrical Engineering Measuring Instruments. By G. D. Aspinall Parr. With 370 illustrations. Blackie and Son. 9s. net.

Electrical Influence Machines. Their Historical Development and Modern Forms, with Instructions for Making Them. By John Gray, B.Sc. Second Edition. With 105 illustrations. Whittaker and Co. 5s.

Electrical Engineering. An Elementary Text Book, suitable for Persons employed in the Mechanical and Electrical Engineering Trades, etc. By E. Rosenberg. Illustrated. Harper Bros. 6s.

Electricity as Applied to Mining. By Arnold Lupton, G. D. Aspinall Parr, and Herbert Perkin. 170 illustrations. Crosby, Lockwood and Son. 9s. net.

Heating and Ventilation of Houses. By C. F. Townsend. Illustrated. (Rural Handbooks.) Dawbarn and Ward. 6d. net.

NEW CATALOGUES & TRADE PUBLICATIONS.

The British Thomson-Houston Company, Ltd., Rugby.—Pamphlet No. 145, illustrating and describing a combined switch and cut-out, which has been specially designed for car-lighting circuits. It consists of a single pole-snap switch, with an extra long bracket connected in series with an enclosed fuse. All contacts and connections are mounted on a porcelain base, and the terminals are suitable for either back or front wiring. A porcelain cover held in place by metal clips encloses all the live parts of the mechanism, which it is claimed makes the device fireproof.

The Horsfall Destructor Company, Ltd., Leeds.—We have received from this firm a neat illustrated booklet, being a descriptive report and souvenir of the new Refuse Destructor Works at Doughty Road, Grimsby, which were erected by the Horsfall Company, and opened on June 6th, 1903. We understand this destructor is capable of burning forty tons of refuse per day, and the total cost is not likely to exceed £10,000. An interesting description of the scheme is given, and some excellent half-tone portraits of the Mayor and principal members of the Destructor Committee, as well as several views of the works, also appear.

The St. Helen's Cable Company, Ltd., Warrington.—A well-designed illustrated price list of 86 pages and cover, describing their principal manufactures, including electrical cables, rubber goods, etc. The chief specialities mentioned are vulcanised rubber cables, india-rubber buffers for railway wagons and carriages, valves, sheets, washers, insertions (both cloth and wire gauze), roller covering, india-rubber gloves, indiarubber and other belting; "Dialite" mats and stair threads, cab tyres, and carriage brake blocks; the patent "N" tape for jointing purposes, horse-shoe pads, hose, vacuum pipes, tubing, etc., engine packing, and all classes of asbestos and gutta-percha goods, etc.

William Asquith, Ltd., Halifax.—List No. 81. An eight-page illustrated pamphlet, printed in two colours, entitled "A Combined Horizontal Drilling, Boring, and Milling Machine for boring cylinders, liners, brasses, etc., to face pipe flanges, valve seatings, or to mill forgings, castings, keyways in shafts, etc." It is claimed that this machine saves a good deal of hand labour, being capable of boring "truly cylindrical parallel holes in one piece of work in different horizontal planes without re-setting, and parallel with each other, thus combining the advantages of several special machines though occupying the floor space of one machine only." A useful table of dimensions is given which, it is explained, can be varied to suit special requirements.

The Washington Chemical Company, Ltd., of Washington, Co. Durham. — A descriptive illustrated pamphlet of thirty-two pages, with inset price list, treating on Magnesia covering, which is this firm's principal speciality. We are told that 85 per cent. of this substance is composed of magnesia carbonite, which is the magnesia alba of the pharmacists. It is a smooth, white, close-grained solid, possessing the "lightness of cork, the porosity of a sponge, and hardness and strength in an exceptional degree." It is also claimed to be most valuable as a non-heat conductor. Detailed instructions for applying this covering to all kinds of piping, together with sectional drawings, are given, and a prominent feature of the booklet is the very fine whole-page illustrations of steam yachts, boiler houses, electric power stations, etc., where this speciality has been largely used.

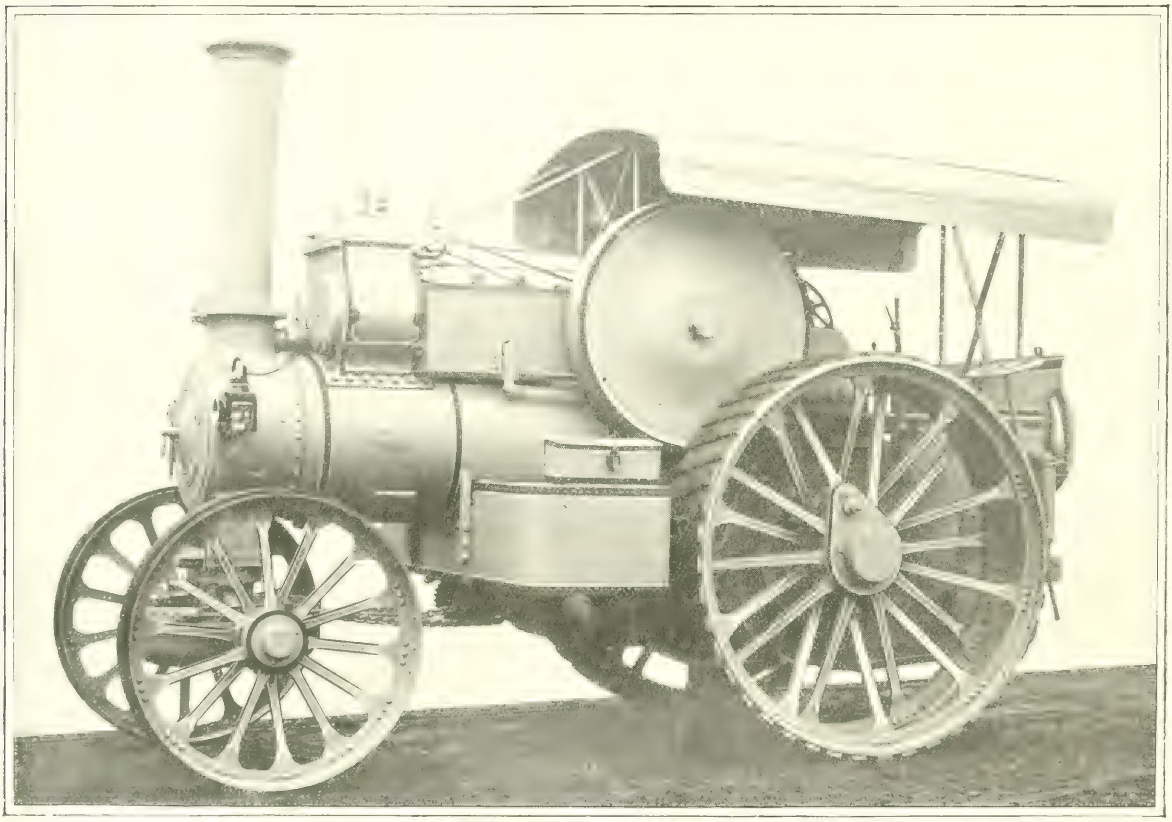
Messrs. Alley and MacLellan's new catalogue, No. J. 22, of Steam Valves and Fittings, reaches a high-water mark in catalogue compilation, whether considered as a complete guide to the necessarily complicated detail of the subject, a model of intelligent arrangement, or a specimen of first-rate printing. It begins with an index of contents, and ends with an informing article by Mr. W. J. Poole, on "Steam Pipe Design." The intermediate pages, about 150 in number, are packed with details of the firm's specialities, half-tone illustrations of the various valves and fittings being accompanied in many cases by sectional drawings. The work, which includes many useful hints on the practical arrangement and working of steam pipes and valves, cannot fail to be of great value to all steam engineers, giving as it does full details as to prices, dimensions, and weights. Incidentally we are reminded that the firm's Sentinel Works at Glasgow turn out valves and fittings for marine purposes, air compressors, high-speed steam engines, condensing plants, stearing gear, hoisting machinery marine engines and light draught steamers. Three illustrations of the latter are representative of 260 light draught vessels built by Messrs. Alley and MacLellan during the past twelve years.

"A New Business Force" is the title given to a cleverly designed pamphlet issued by the Addresso-graph, Ltd., 91 and 92, Shoe Lane, E.C. The illustrations show at a glance that the Addressograph is now used effectively in combination with the card system. A number of uses to which the machine can be applied are carefully described, but these, we imagine, form a very small proportion of its successful operations. Stress is laid upon the reliability of the Addressograph, its great use in preparing and despatching statements, its services on behalf of travellers, and the saving of time it effects in the shipping room, etc. There is certainly much to be said for a machine which will turn out addresses at the rate of 2,000 an hour with perfect accuracy and legibility, and those who are called upon to deal with badly addressed envelopes, or have much to do with circularising, have every reason to welcome the Addressograph.

JOHN FOWLER & CO. (LEEDS) LIMITED.

Electrical and General Engineers.

Steam Plough Works: LEEDS.



Fowler's Road Locomotive. Designed for all kinds of Steam Haulage, and is also available for temporary belt driving. Three sizes of this Engine are standardized, and employed approximately for 20, 30, and 40 ton loads. A special heavy Engine is also made equal to a load of 50 tons, and called the "Lion" type. The Engine was thus named by the War Office Authorities, who employed a number of them in the South African Campaign.

TANGYES

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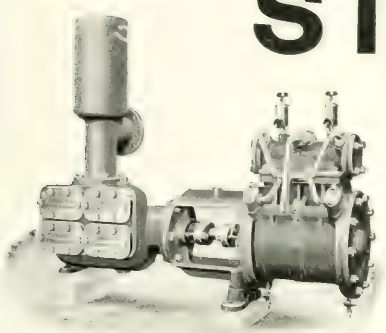

14 × 8 × 12 in. "Special" Pump.

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"SPECIAL" DUPLEX
FLY-WHEEL, &c.,

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Centrifugal Pumps, Treble-Ram Pumps, etc.

Electrically Driven Pumps

A SPECIALTY.

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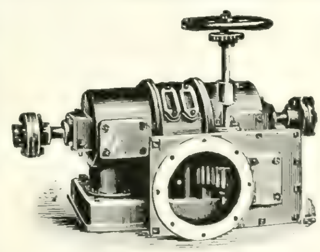

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Hydraulic and Mining Engineers,

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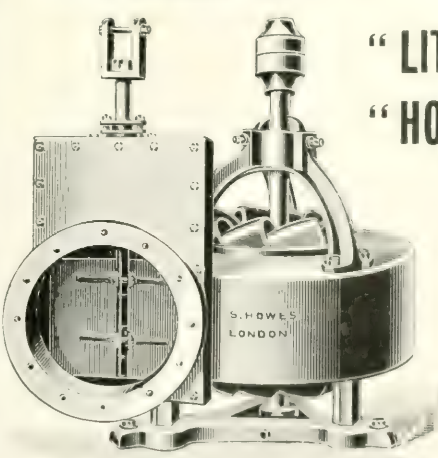

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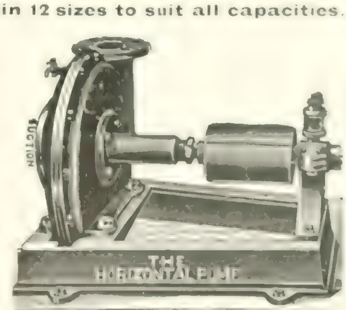

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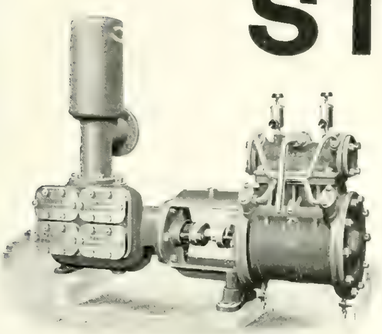

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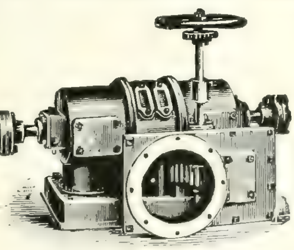

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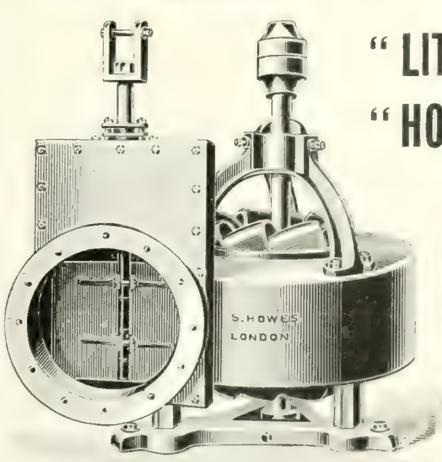

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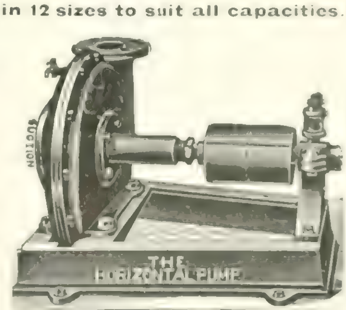

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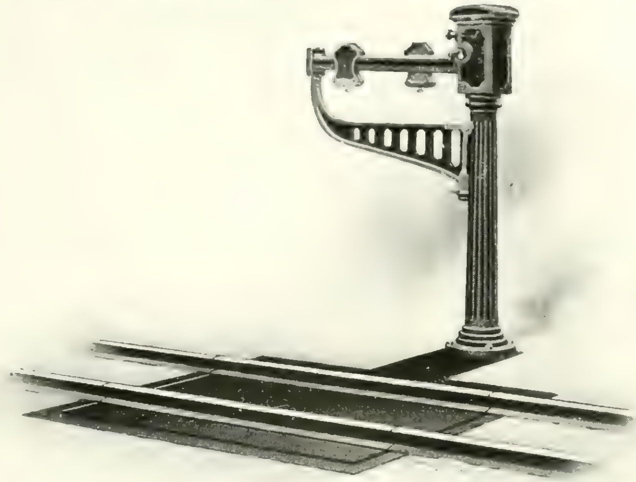

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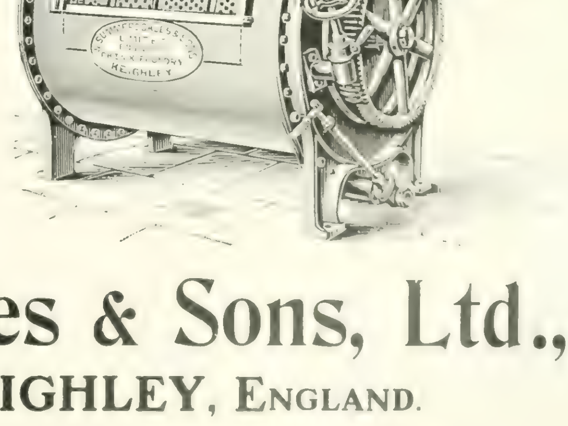

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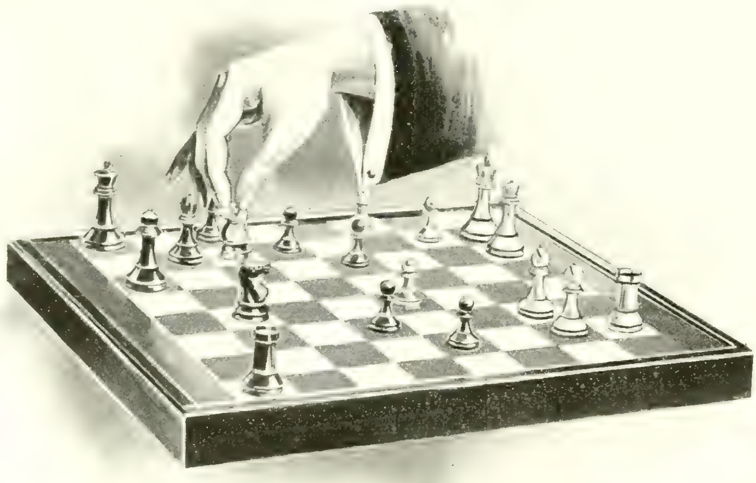

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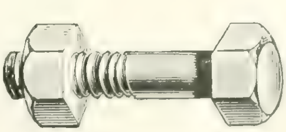

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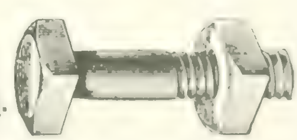

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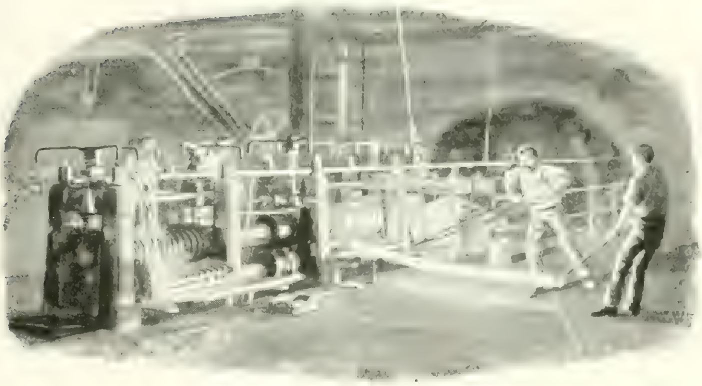

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Farnley **Bar Iron** is used in **Mining** for pit cages, suspending gear, and other important parts, and on all the leading **Railways** in Great Britain, India, and the Colonies, for shackles and other vital parts subjected to repeated shocks.

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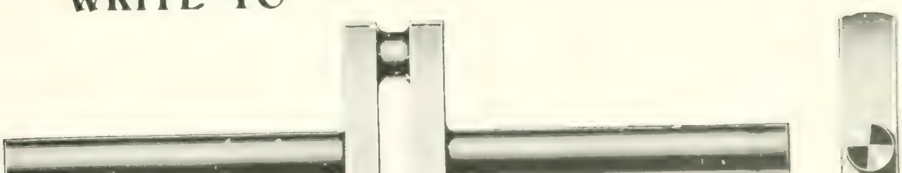

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THOMAS PIGGOTT & Co., LTD.,

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GAS, HYDRAULIC and GENERAL ENGINEERS.

Gas Plants and Constructional Ironwork of all descriptions.
Columns, Girders, Castings.
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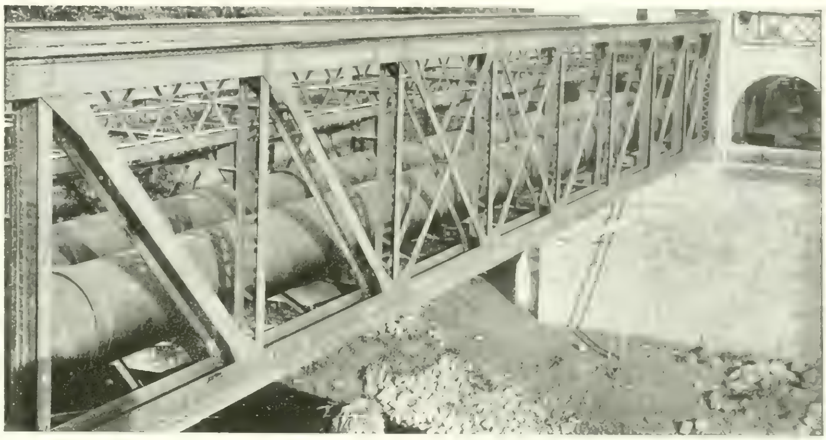

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Maximum reduction with minimum loss by evaporation.

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IT IS A FALLACY to suppose that you can obtain the same results with badly cut or cast gearing as you can with that which is machine-cut and accurately made. The advantage of the latter is that it runs smoothly and absorbs a minimum amount of power even when working at high speeds.

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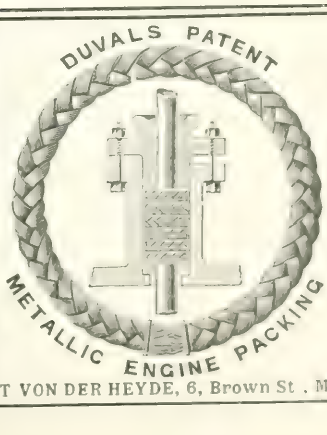

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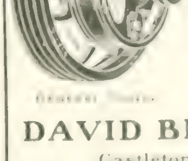

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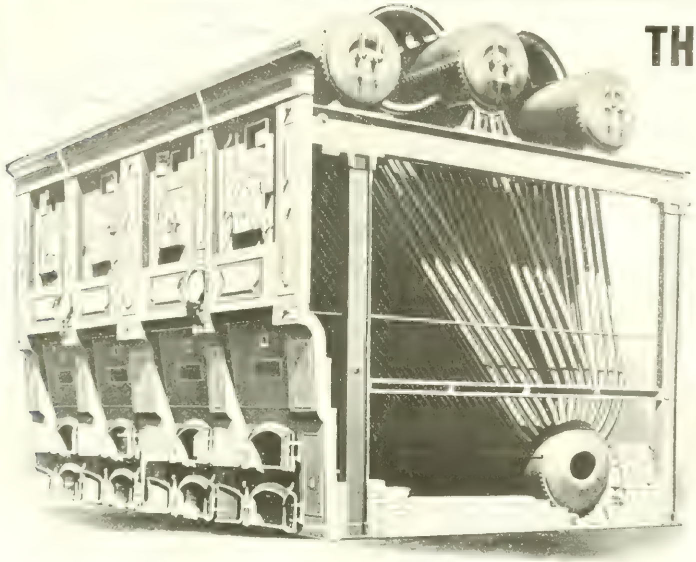

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Specially suitable for Firing by Gas from Blast Furnaces or Producers, or for utilising Waste Heat from Heating Furnaces. Upwards of 1,400,000 H.P. of our Boilers in operation.

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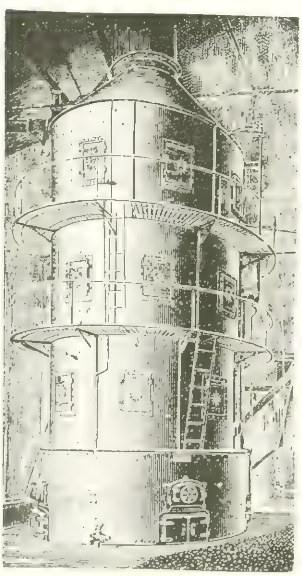
'CLIMAX' WATER TUBE BOILER



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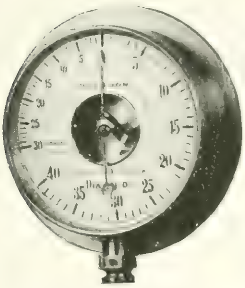

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Hunt and Mitton,

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HIGH-CLASS FITTINGS ONLY

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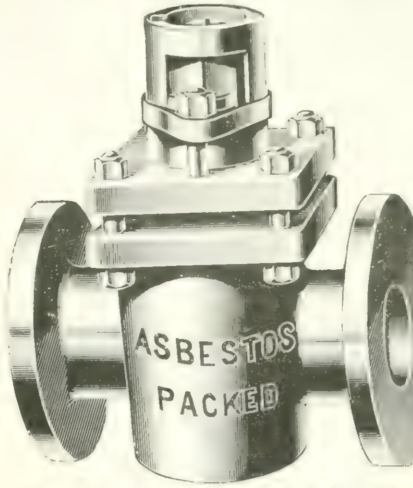

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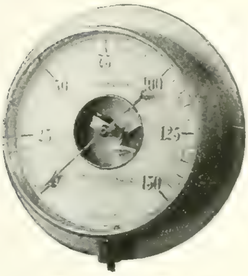

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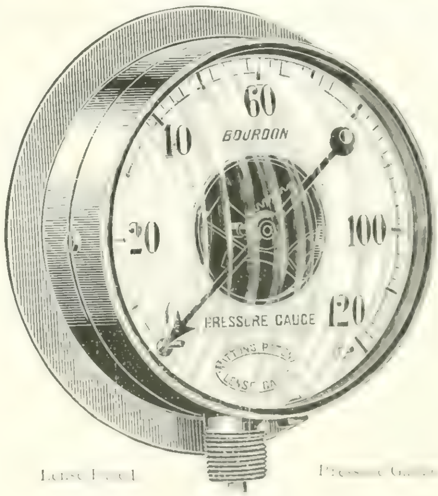
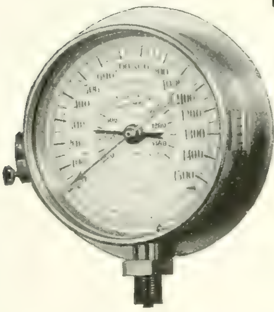
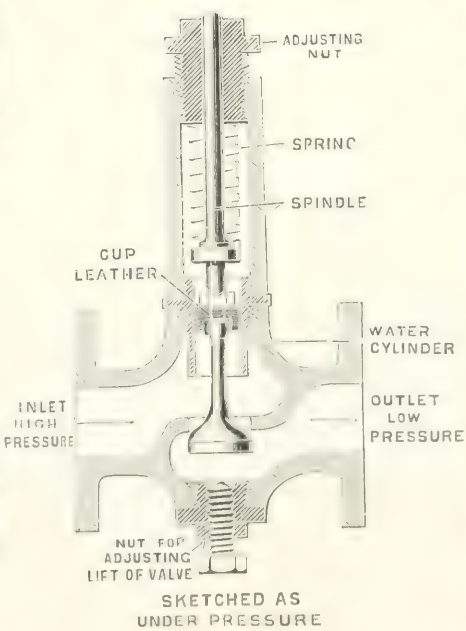


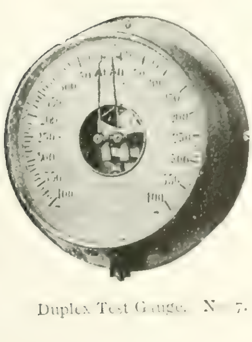
Lense Fitted Pressure Gauge.



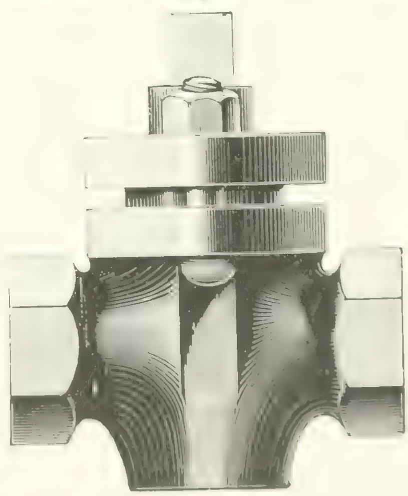
Hydraulic Gauge. With Maximum Hand and Lock and Key.



Reducing Valve.



Duplex Test Gauge. No. 7.



Screwed Gland Cock.

THE HUNSLET ENGINE CO., LTD.,
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MANUFACTURERS OF

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Of all Descriptions.

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Telegrams: "Engine, Leeds." Telephone: 528.

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If you are in the market for CONCENTRATING MACHINERY, send for particulars of the No. 4 WILFLEY TABLE, to be obtained of the Sole Proprietors:—

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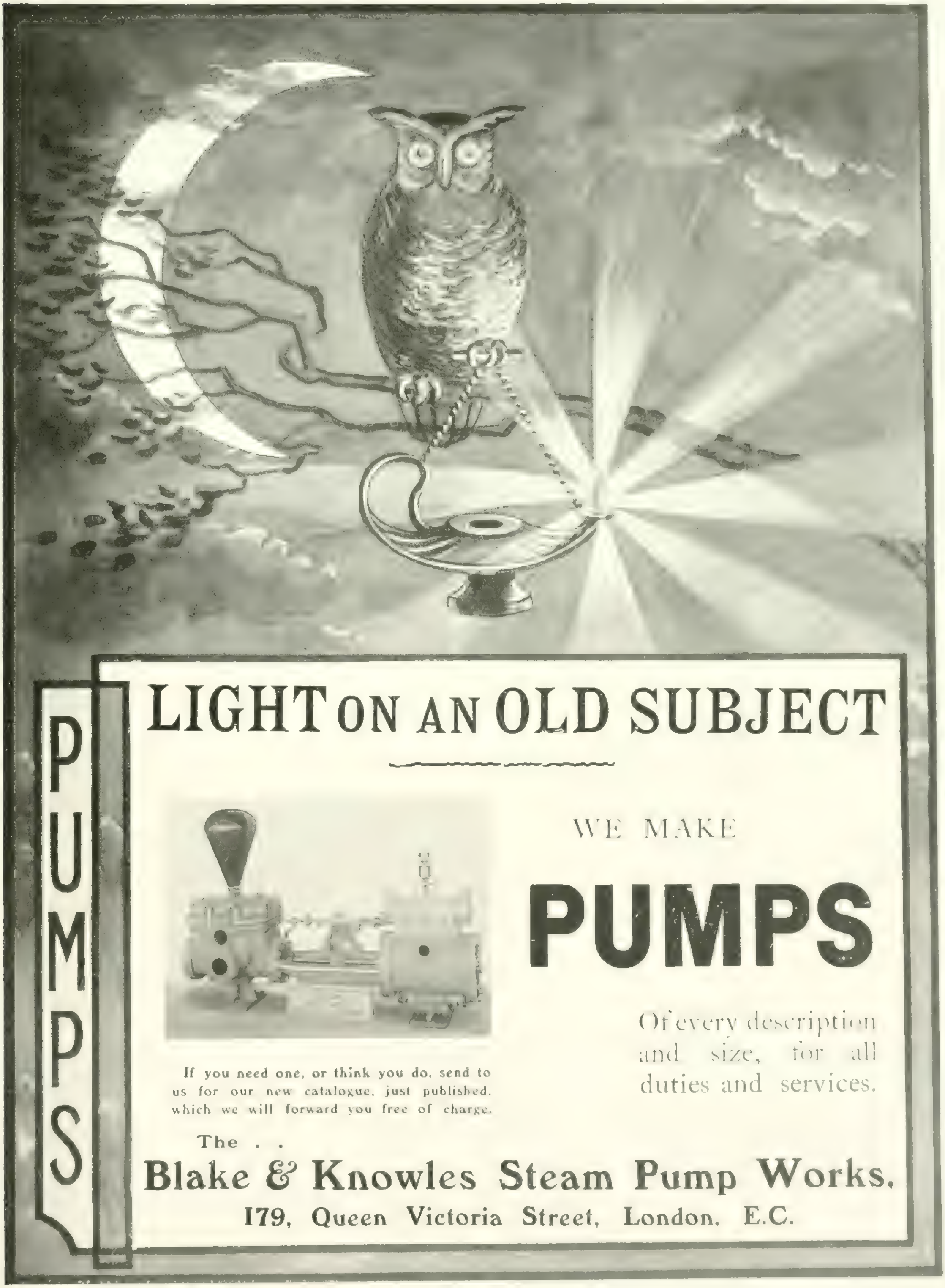
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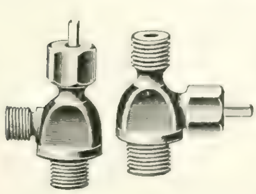

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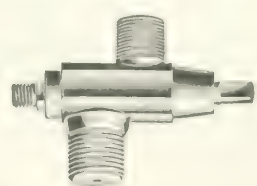

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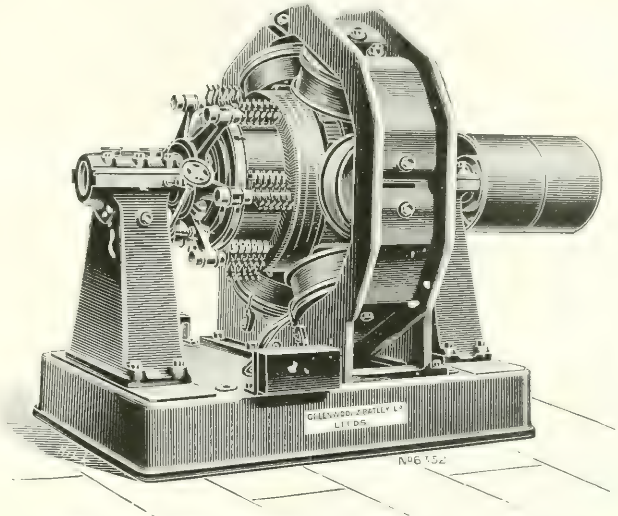

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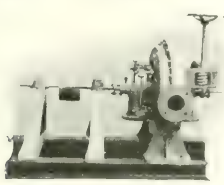

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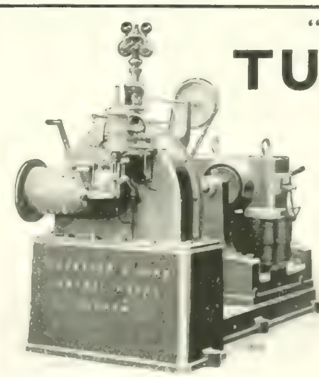

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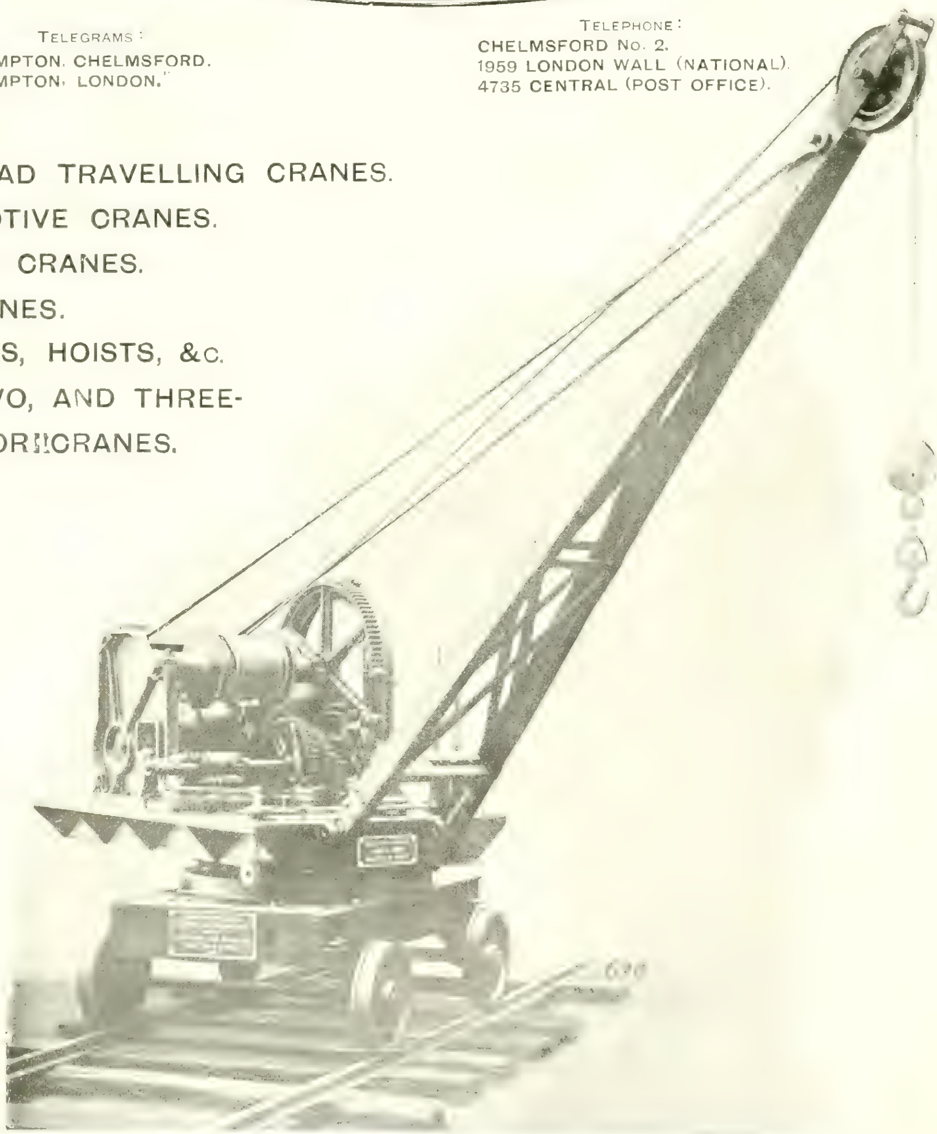

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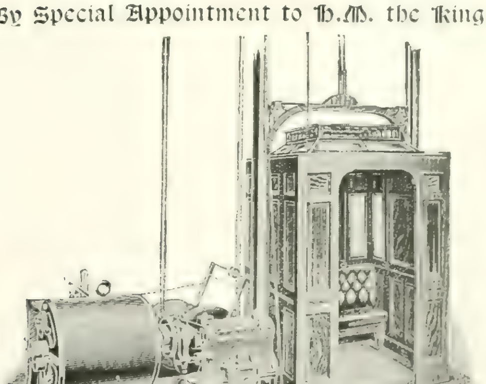

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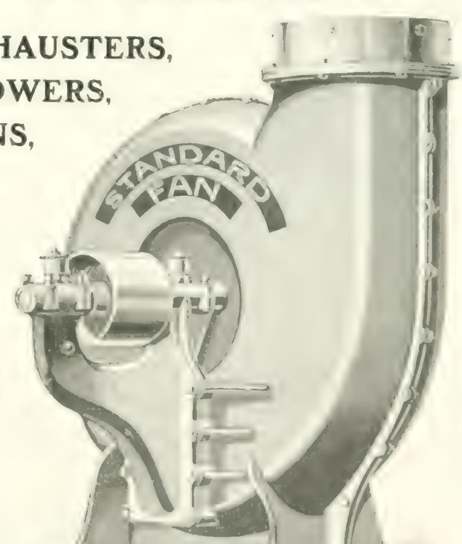

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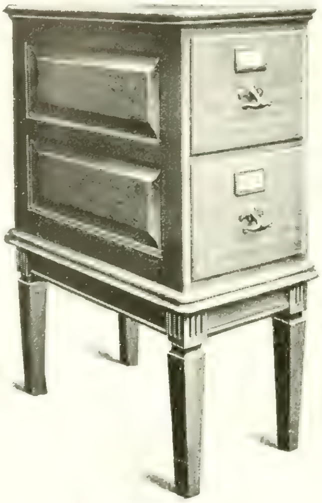

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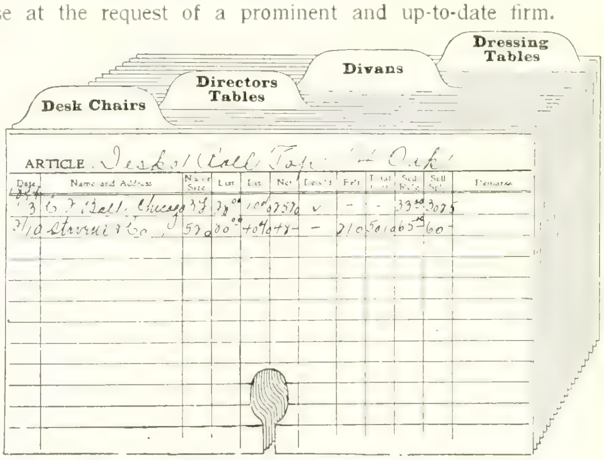

Fig 5. Special Subject Guides.

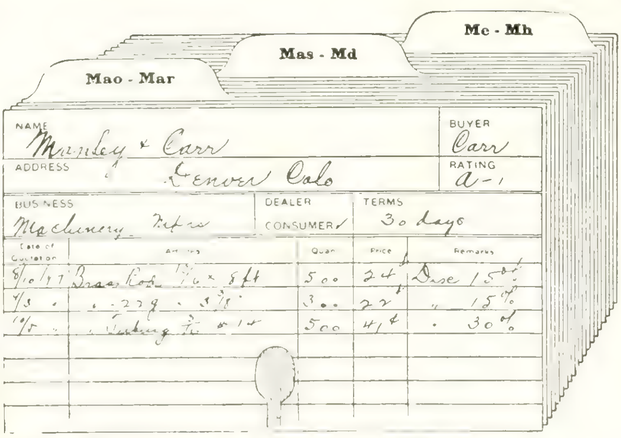

Fig 6. Guides from a set of 320 Alphabetical Subdivisions.

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